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ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

Aeromedical Aspects of Helicopter Operations in the Tactical Situation

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MAY 1967

NORTH ATLANTIC TREATY ORGANIZATION

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AEROMEDICAL ASPECTS OF HELICOPTER OPERATIONS IN THE TACTICAL SITUATION

Advisory Group for Aerospace Research and Development
Paris, France

May 1967

SUMMARY

This volume contains the text, discussions and Chairman's Summaries of 26 papers presented at the AGARD Aerospace Medical Panel's three day meeting on the medical aspects of helicopter operations held at NATO Headquarters, Paris, France on 22-24 May, 1967. The delegates included clinicians, physiologists, engineers and operators; many of them were serving officers of NATO countries. The papers are grouped under four main headings: The Helicopter as a Carrier of Personnel and Material, The Helicopter as a Casualty Evacuation Vehicle, Aircrew Problems in Helicopter Operations, and Hazards of the Helicopter. In addition, there is a paper on The Hovercraft and its Potentialities.

RESUME

Dans le présent ouvrage on publie le texte de 26 communications présentées à la réunion de trois jours organisée par la Commission de la Médecine Aérospatiale de l'AGARD et consacrée aux aspects médicaux de l'exploitation des hélicoptères qui s'est tenue au siège de l'OTAN, à Paris, France du 22 au 24 mai 1967, ainsi que le texte des discussions qui ont suivi les exposés et des résumés faits par le Président. Parmi les délegués se trouvaient des cliniciens, des physiologues, des ingénieurs, des exploitants, dont plusieurs étaient des représentants des forces armées des pays de l'OTAN. Les exposés se groupent sous les quatre titres suivants: L'Hélicoptère comme Moyen de Transport de Personnel et de Matériels; L'Hélicoptère comme Véhicule d'Evacuation des Blessés; Les Problèmes que pose pour le Personnel Navigant l'Exploitation des hélicoptères; et Les Dangers présentés par les Hélicoptères. Un mémoire a également été fait sur L'Aéroglisseur et ses Possibilités.

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NORTH ATLANTIC TREATY ORGANIZATION

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT

(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

AEROMEDICAL ASPECTS OF HELICOPTER OPERATIONS IN THE TACTICAL SITUATION

Papers presented at a Symposium held by the Aerospace Medical Panel of AGARD
at NATO Headquarters, Paris, France
on 22-24 May, 1967

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PREFACE

The symposium which is the subject of this report was conceived during a meeting of the Technical Programme Committee of the Aerospace Medical Panel of AGARD in October, 1966. The aim was to bring together clinicians, physiologists, engineers and operators to exchange information and ideas on aero-medical aspects of a currently highly topical field of operations. From what was initially considered a basis for a possible two-day meeting there sprang a packed programme for three working days, and even then some papers had to be curtailed, or declined and discussion curbed.

If enthusiasm of participants is a measure of success, this meeting must be regarded as outstanding. As project officer I am personally deeply grateful to all who took part for their kind forbearance in tailoring their presentations in accordance with my suggestions. It is hoped that the outcome was a successfully balanced programme.

So far as this published account is concerned, I am indebted to all those authors who so kindly co-operated towards its relatively speedy production. I have taken liberties here and there with the text - I hope that the results are acceptable. The discussion sessions after each paper are recorded in summary from my notes. If speakers are misinterpreted or misrepresented this fault is entirely mine. In the interest of speed I have not submitted drafts to speakers or used direct transciptions from tape-recordings. I trust that the results are an acceptable version of the actual discussion.

Finally I must thank not only all the session chairmen, speakers and discussion participants, but also all those members of the AGARD and RAF Institute of Aviation Medicine staffs who have worked so hard in typing manuscripts, preparing translations, re-drawing illustrations and performing the myriad other tasks without which publication would not have been possible.

D. I. Fryer
Wing Commander
Chairman, Editorial Committee
Aerospace Medical Panel
Project Officer

OPENING ADDRESS

Dr W.P.Jones, the Director of AGARD, opened the meeting by explaining briefly the origins of the project and its aims. He was delighted to see so many countries represented and hoped that all present would enjoy the programme, which looked extremely interesting.

He took pleasure in introducing Major General Stromberg, MCNEP, whose presence was a valuable indication of the interest shown in the meeting by the Military Committee of NATO.

WELCOME ADDRESS BY MAJOR-GENERAL STROMBERG

"Gentlemen:

In welcoming you in the name of the NATO International Staff, our hosts, and on behalf of the Military Committee which I am representing here at the NATO Council, I have the honour to address myself to you as the leading personalities of the NATO nations in the field of Aerospace Medical Science.

The results obtained already in the past, by AGARD as a whole, have demonstrated that the particularly flexible working system of the various Panels, representing and making use of the individuality and freedom which are precious and necessary to the scientist, gives to those who are responsible for defence, the best scientific advice and the chance of exploiting its immediate or future possible applications.

However, AGARD's activities are not limited to studies for the exclusive and direct benefit of the higher Military Authorities. It is indeed this flexibility which enables you to offer your brilliant scientific knowledge and inspiration to all the other NATO bodies involved in defence research.

May I recall here the recent resolution of the National Delegates Board of AGARD, endorsed by the Military Committee and brought to the attention of the North Atlantic Council (MCM-137-66, dated 1 November 1966) which stresses that from our side, whilst maintaining AGARD's efficient structure and working principles under the aegis of the Military Committee, we are endeavouring not only not to lose but even to increase the harmony which always governed the fruitful co-operation between AGARD and other NATO bodies concerned.

As regards your symposium today, may I assure you that your discussions will be followed with the highest interest. In fact, this is the first time that the entire medical aspect of tactical helicopter operations will be studied in the light of recent experiences made by a large number of countries here represented.

I am especially grateful that such a study is being undertaken by AGARD which has already produced, a year ago, a very concise report on the tactical aspect of helicopter development.

There certainly exists an inter-relationship between the conclusions of both this technical report and your studies and it might well appear that the outcome of these two exercises, complementing each other, would stimulate the concept of the designers as well as of the users of helicopters.

The detailed preparation and, I am sure, the most useful results NATO can expect from your symposium, will put into the right perspective once more AGARD's ability and capability in the field of defence research. In leaving somewhat aside this time the pure "space" aspect and coming down to the "ground", which applies to a number of specific problems concerning Army Aviation, you will give also another example of AGARD's flexibility and its willingness to contribute to NATO Defence wherever feasible and possible.

In closing, permit me to convey the Military Committee's wishes for a profitable meeting. On its behalf, I would like to assure you of the interest it has in your work and I wish you a complete success in the accomplishment of your mission."

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SESSION IV

Hazards of the Helicopter

US ARMY HELICOPTERS AS PERSONNEL AND MATERIAL CARRIERS

by

Colonel R.L.Cody

Aviation Directorate, OACSFOR

RESUME

L'utilisation des hélicoptères au Vietnam - leur rôle d'appui dans le domaine de la mobilité tactique, de reconnaissance et de surveillance, de puissance de feu, de logistique, et de commandement et de contrôle. L'influence de la nature du terrain et des conditions météorologiques sur leur emploi. Les hélicoptères sont utilisés pour une gamme variée de missions connexes telles que le soutien d'avant-postes isolés et l'aide à la guerre psychologique grâce au largage de tracts et au transport de haut-parleurs.

US ARMY HELICOPTERS AS PERSONNEL AND MATERIAL CARRIERS

Colonel R.L. Cody

I hope today to be able to give you an appreciation of the extraordinary developments we are experiencing in Vietnam in the application of helicopter capabilities to the conduct of land combat by the US Army.

I shall present this subject in these five phases:

1. Combat environment.
2. Helicopter employment in Vietnam.
3. Tactics and techniques.
4. Associated helicopter missions.
5. The nature of the US Army helicopter effort in Vietnam.

THE ENVIRONMENT

With respect to environment, I feel sure that most persons present are generally familiar with the area so I will emphasize only those aspects which most affect helicopter operations.

South Vietnam is marked by three general types of terrain, the Mekong Delta area, the Coastal Plain and the Central Highlands. The open rice paddies and small amount of vegetation in the delta region facilitate the selection of landing zones, both primary and alternate. However, the lack of obstructions makes it easier for the enemy to fire on our aircraft with their automatic weapons. The coastal plains have many of the characteristics of the delta region, however, landing zones often are more difficult to locate. Roads are fewer and more poorly maintained. East-west ridges extend from the inland mountains to the shore making north-south land movement extremely difficult. The central highlands terrain presents the greatest hazards to airmobile operations. Rugged mountains coupled with vast areas of jungle severely limit the selection of suitable landing zones. The high trees surrounding landing zones present real hazards during approaches and departures.

The weather of Vietnam stems from two monsoon cycles; the Northeast and Southwest. The Northeast monsoon season occurs generally between the months of September and April. It brings the wet season to the coastal plains and the dry season to the delta and highland regions. Heavy clouds along the coastal mountains restrict air movement in that area while hot, dusty conditions exist in the delta and highlands. Conversely, the southwest monsoon, which occurs from April to September, is marked by low ceilings

and poor visibility most of the time in the central highlands, frequent reduced visibility in the delta and generally good weather along the coastal plains. We have gained a great deal of experience over the past year and a half and can now operate successfully under much worse conditions than previously.

THE ENEMY

In general the Vietcong (VC) and the North Vietnamese Army soldiers are tough, tenacious and ingenious. They fall into three categories with respect to their overall effectiveness. At the top of the scale are the North Vietnamese Army soldiers. They are well trained, well equipped and are better organized and led than the Vietcong. They possess more antiaircraft automatic weapons in their units than the VC and are adept in their location and employment. Next in the scale are the hard-core Vietcong. They are organized into military-type units; however, their weapons and equipment are inferior to those in North Vietnamese Army units and thus limit their overall effectiveness. They are particularly well trained in guerrilla tactics and are ingenious in their use of mines, booby traps and other field expedients. At the end of the scale are the local Vietcong cells or units. They lack adequate arms and equipment to make them effective as military units; however, they excel in guerrilla actions such as ambushes, sabotage and acts of terrorism. All of the enemy forces have the distinct advantages of being thoroughly familiar with the terrain in which they operate, and they are physically well adjusted to the climate. As a result, they are able to make the best use of the terrain by selecting the most advantageous time and place for offensive actions and, when desiring to escape being trapped, can cover great distances in areas where detection is next to impossible. For these reasons, the tactical mobility of allied forces in Vietnam has become an absolute essential and the helicopter has done much toward giving us that mobility.

THE USE OF HELICOPTERS

The use of the helicopter as a personnel and material carrier in the US Army has been designed to meet the mission requirements of what we consider to be the five major functions of land warfare. These are:

1. Tactical Mobility.
2. Fire Power.
3. Reconnaissance and Surveillance.
4. Logistics.
5. Command Control.

Our fundamental consideration in developing Aviation organizations and the techniques for their employment has been to assign aircraft and their operators at the lowest possible command level, so that they will be readily available and quickly responsive to the needs of the ground commander. With this in mind, we have designed certain helicopters with the flight capabilities to fit the requirements of the five major functions of land combat. We also have organized these helicopters in units which are designed to give the rapid responsiveness the ground commander needs.

In relating the use of the various helicopters in the five functions of land warfare I would like to illustrate with film from Vietnam the versatility of several of the aircraft in that they are used to accomplish two or more of these functions.

The execution of airmobile operations requires careful planning, meticulous coordination and close command control.

In discussing the techniques of US Army airmobile operations I must emphasize that helicopter employment is geared directly to the plans and needs of the ground commander.

In the Planning and Reconnaissance phase, the ground commander develops a tentative plan to accomplish the mission assigned him. This is usually done on the basis of a map reconnaissance with the assistance of the aviation commander. Tentative landing zones are selected and plans are made for pickup of troops at the forward operating base, loading and unloading, fire support, communications and command arrangements. This is followed up by a reconnaissance by helicopter, during which the ground commander, air commander and air- or artillery-liaison officer confirm plans already made or make changes to the plans which actual viewing of the terrain may dictate. Upon return from the reconnaissance, appropriate commanders confirm arrangements for fire support by tactical air, armed helicopters and ground weapons such as artillery and mortars. Plans for the air movement phase are confirmed to include take off time, loading time, time for the prestrike on the landing zone, landing time and the requirements for follow-up delivery of weapons, ammunition and supplies. Communications procedures are agreed upon and published.

On the day of the airmobile operation the aircraft are assembled at the forward operating base in time to load troops and equipment and take off at the agreed time. The flying time to the landing zone has been carefully calculated so that the aircraft formation arrives at the landing zone at the exact time the air or artillery preparatory fires terminate. Armed helicopters escort the troop carrier aircraft into the landing zone and deliver suppressive fire on the edges of the landing zone while the troops are unloading. Special medical evacuation helicopters usually accompany the formation and stand-by in the event there are casualties requiring evacuation.

After all troops and weapons are delivered to the landing zone the armed helicopters are often kept on station directly overhead to deliver immediate fire support for the ground combat units. Aero medical helicopters also often remain in the area during the early stages of the operation, and then later go on a standby basis at the forward operating base to be called in as required.

Should the operation fail to make contact with the enemy, new plans are made and the troops are shifted to a new area of operation to continue the search.

Up to now I have discussed only preplanned operations in which a deliberate planning and reconnaissance process was followed. There have been numerous instances of immediate reaction in which large numbers of troops have been rapidly moved in response to intelligence on enemy activities or in reaction to actual enemy attack on friendly units of outposts. In cases of this type planning and reconnaissance steps are compressed in time so that reaction is nearly immediate. Success of this type operation depends on good communications and understanding on the part of all participants of standing operating procedures for airmobile operations.

Upon termination of the operation, helicopters recover troops, weapons and supplies from the battle area and return them to base camps.

SPECIAL MISSIONS

Now a few brief comments on other special missions accomplished by our helicopters in Vietnam.

One of the most appreciated types of support is that given to isolated Allied outposts of various types. These camps are located many miles from centers of population and have no surface means of transporting supplies, personnel and mail. If it were not for the frequent helicopter flights which reach them easily, they would not be able to accomplish their mission.

Another major collateral mission is the support of consolidation operations. These operations are primarily the responsibility of the Vietnamese and are designed to re-establish friendly control over large areas and a great number of the population previously under control of the Vietcong. We support the military operations that cause the Vietcong to leave the areas; we position friendly forces that insure local security and we airlift the special advisory teams such as medical, agricultural, commerce, and construction that assist the liberated villagers in restoring order and prosperity to their areas. Local and National officials are transported so as to supervise the accomplishment of these tasks.

In recent months Allied forces have been increasingly successful in implementing the "Chui Loi" or "Open Hand" program. This program is designed to encourage members of the Vietcong to lay down their arms and to join the side of freedom. Our helicopters have given outstanding support to this program by mounting loudspeakers for transmitting messages to the Vietcong wherever they are or by dropping leaflets which inform them of the advantages of joining in the Open Hand program.

I have generally covered the specifics of our airmobile concept and the functions our helicopters perform. The means with which we accomplish this mission include helicopters organized into various types of units, such as air cavalry, utility, medium cargo or heavy lift helicopter companies. Each is designed to accomplish a specific task and is assigned to support those ground combat units having the highest priority at any given time. Their speed, range and versatility allow them to be shifted quickly and effectively from area to area thus responding to the actions of the enemy or in accordance with the plans of ground commanders.

To give you an insight into the scope of these operations, I would like to quote a few statistics.

During the months of January and February 1967 our helicopters flew approximately 180,000 hours in the performance of our 600,000 sorties. We carried over 70,000 tons of cargo and lifted over 870,000 troops. To do this each of our pilots averaged 90-110 flying hours per month and many of them flew as much as 130-140 hours. Such accomplishments are unprecedented in US Military history.

I recognize that this has been a fairly limited view of the use of US Army helicopters as personnel and material carriers in Vietnam. However, I trust it has given a fair insight into these operations as a means of measuring the problems and requirements inherent to organizing, training, deploying and supporting the organization required to accomplish these missions. Subsequent presentations in this symposium will address many of the problems of safe operation, pilot training, fatigue, motivation and operational techniques - all of which relate closely to successful mission accomplishment.

DISCUSSION

Wg Cdr Eley, congratulated the speaker on the excellence of this overall review of US Army equipment and techniques. He noted that in an illustration of the attachment of a heavy under-slung cargo to the heavy-lift helicopter, no head protection was worn. Was there not a very severe degree of turbulence due to down-wash below such a large rotor disc, and was there not a danger of head injury?

Col Cody replied that the turbulence was in fact less than that below the tandem-rotor Chinook helicopter, and that this particular 'flying-crane' type machine was generally operated from reasonably well-prepared areas. Head protection was clearly advisable but was extremely difficult to provide. **Wg Cdr Fryer** stated that the RAF had under development a one-size protective helmet and **Capt Perry** confirmed that samples had been received by the Army Air Corps. **Col Cody** expressed interest in this development and emphasised the difficulties even with multi-size aircrew helmets in the achievement of adequate fit.

Col Kriebel asked whether night operations were widely used in Vietnam. **Col Cody** stated that they were severely limited by lack of adequate navigational techniques and the hostile mountainous terrain. It was felt that it was too hazardous to attempt to land pathfinder teams to set-up landing zones in the face of the type of enemy disposition encountered.

Wg Cdr Eley expressed surprise at the mention of operating figures for pilots of as high as 130 to 140 hours per month. He asked whether there was much evidence of fatigue. **Col Cody** replied that fatigue was sometimes a problem - it would be dealt with later in the programme. Ideally he would like to see a limit of 90 hours per month set for aircrew on operations.

RAF EXPERIENCE OF HELICOPTER OPERATIONS IN BORNEO

by

Wg Cdr D.Eley, RAF

Chief Flying Instructor, School of Army Aviation,
Middle Wallop, Hants., UK

RESUME

Conditions générales à affronter.

Rôle des hélicoptères dans le soutien des forces terrestres.

Conditions opérationnelles: terrain, conditions météorologiques.

Problèmes de recherches et de sauvetage, atterrissages brutaux.

Tâches aux altitudes élevées.

Certains problèmes posés au pilote d'hélicoptère au cours d'opérations dans la jungle: navigation, communications, langue, stress thermique, brûlures par contact, insectes et maladies.

RAF EXPERIENCE OF HELICOPTER OPERATIONS IN BORNEO

Wg Cdr D.Eley, RAF

A BRIEF HISTORICAL BACKGROUND TO CONFRONTATION

Like earlier political leaders of Indonesia, Dr Soekarno's dream was to unite all the islands of that Archipelago to form a Greater Indonesia.

After the failure of the internal revolt in Sumatra in 1959 he gradually gained sufficient power to absorb West Irian; this he achieved by August 1962. After this success he turned his attention to swallowing up the remaining part of the Island of Borneo. He was assisted by Azahari, the Brunei political leader, who, with the help of Indonesian trained cadres, initiated a revolution in December 1962. The uprising was soon suppressed, however, by British troops rapidly deployed from Singapore.

The Confrontation Campaign which then followed was directed initially against the formation of, and subsequently against, the Federation of Malaysia. In Borneo it took the shape of sporadic incursions across the ill-defined 1000 mile border dividing the Malay states of Sabah and Sarawak from Indonesian Kalimantan. Later it was stepped up and both parachute drops and sea-borne landings were made at various places on the Malayan mainland, notably in Johore State.

THE DEVELOPMENT OF HELICOPTER OPERATIONS

Naval and RAF helicopters, later supplemented by Army helicopters, were committed to supporting the ground forces patrolling the border and defending strategic points. Of necessity, the troops were very thinly spread with many patrols consisting of only four or five men with a frontage of several miles to police. Their role was really that of a trip-wire and their task was to see the enemy and radio back information without themselves being detected. Without helicopter support to move men and supplies this operation would have needed many times the number of troops, or taken many more years to complete.

To give a typical, first hand, instance of the initial effort - I was at the time commanding No. 110 Squadron equipped with Sycamore helicopters at Butterworth in North Malaya. On Christmas Eve, 1962, shortly after the Brunei revolt, a detachment of three Sycamores was air-lifted by Beverley transports into Labuan in Sabah. On the following day they commenced operations.

Soon the pilots were flying throughout all hours of daylight in a strange country, out of radio contact, with very limited distribution of fuel stocks and with very crude maps.

Following our experiences in Malaya certain "known" routes were adhered to at the expense of extra flying time to aid Search and Rescue operations in the event of a crash. New pilots were "checked out" along these routes and later used them as base lines from which to explore new areas. One jungle is much like another but in contrast to the many small helicopter clearings in Malaya, most of the early sites used in Borneo were "village" football pitches. I never saw any football but, luckily for us, I gather that the people of the "long houses" boasted of their pitch as some kind of status symbol.

With the arrival of the Whirlwind Mk.10 four months later, larger payloads and longer sorties became possible. VHF and UHF radios provided better range but even so, once out of line of sight, radio contact was lost. A strong plea was made for HF-SSB radios and these were eventually fitted to all Whirlwinds – finally giving a very good radio cover for the whole operation.

As the incursions increased in size and frequency and were better organised the number of Whirlwinds, Belvederes and other service helicopters was also increased. After one or two had been shot at, extra precautions were taken:- fluorescent paint markings were removed, "flak-vests" were issued to pilots and machine guns and gunners were carried. When operating near the border, two pilots were crewed in case one was incapacitated and where possible aircraft flew in pairs. At first pilots were divided over whether to wear their flak-vests or sit on them. Later we were issued with slabs of armoured plate for the seats.

Clearings became most important – for, as the struggle developed the ground forces wished to be dropped or lifted much nearer to the border in order to effect a "cut-off" after an incursion or to carry out a quick patrol in a suspected area. Clearings were therefore cut all along the border.

Deployment was a problem – in order to facilitate servicing and to ensure a correct priority for tasking, all our aircraft operated out of Labuan. This also meant that the aircrews had the benefit of a higher standard of messing and accommodation. On the other hand, this was wasteful of aircraft hours because of the long transit times. Later to reduce "reaction time", forward bases were set up and the aircraft operated from these until due for their next scheduled servicing. Aircrew lived with local Army Units, in improvised camps or in long-houses.

Fuel problems – were overcome by having fuel supplies para-dropped or air-lifted by fixed wing into the clearings or strips to provide geographically spaced stocks covering the areas most commonly used. For tasks off the normal routes fuel was either dropped or lifted in by under-slung load from helicopters.

GENERAL OPERATING CONDITIONS

Usually a jungle mist covered the valleys and low plateaux until about 0830-0930 in the mornings. This then burned off to give clear skies until approximately 1330-1430 hours, after which time a Cumulus build-up occurred, covering all high ground and possibly giving rise to thunderstorms with torrential rain later in the day. It was therefore essential that the best possible use was made of the excellent flying conditions between 0900-1400 hours. On a troop-lift there could well be a

requirement for six or seven journeys with three or four aircraft between the two locations, and therefore every endeavour was made to achieve a minimum turnround time. Originally, because of the fire risk, it was mandatory to stop engines when refuelling, and a turnround inspection was necessitated. This meant delays of up to 30 minutes compared to only about 4 minutes when, later, refuelling with engines running was authorised.

Apart from visibility and heat problems, when the weather had been dry for more than a few hours dust was picked up by the rotor down-wash and covered everything, whereas in wet weather, mud took its place.

On the ground flies and leeches abounded but did not prove a serious problem.

HIGH ALTITUDE OPERATIONS

Helicopter clearings, such as I described earlier, were usually cut on a hill top or ridge rather than in a valley. In this way a minimum number of trees had to be felled and the approach and take-off routes were safer. This practice was also used when we were tasked to support an Army survey team fixing certain known points in relation to one another so that a series of aerial photographs could be used for the production of better maps. The pin-points for the ground survey were, of necessity, on the highest available features, some almost inaccessible due to their shape, the presence of trees, or both. The technique then used was to lower a man with a power saw, by winch, onto a ledge or through the nearest gap in the trees. He would fell enough trees to enable the helicopter to be balanced precariously on one or two wheels while the remainder of the survey team were offloaded together with their theodolites etc. Three "trio-points" had to be manned simultaneously to obtain the correct measurements, then the "rear" party was taken forward to the next point, leap-frog style, until the next measurement was completed, and so on until most of Sabah and Sarawak was covered. The whole task was completed in weeks compared with perhaps several months or even a year by surface means.

Another interesting high altitude task was air-lifting Sabah Radio Station. In order to counter the propaganda transmitted from Djakarta it was planned to move this Radio Station up to a site on Mount Kinabulu, which rises 14,500 ft above sea level. I uplifted the first reconnaissance party and, after waiting some time for the cloud to clear, landed at 6500 ft at the road head. Literally within seconds of touching down there was a wind change which brou .. the cloud down, reducing visibility to a matter of a few yards. There we were stranded from 1100-1730 hours when having completed plans for an overnight stop, it cleared just as suddenly as it had closed in. Before returning to base we reconnoitred the site for the Station at about 9500 ft. It was interesting that when flying between layers of broken cloud, and with rain on the windscreen I experienced for the first time, the sensation of "vertigo". I also realised how careful one had to be to keep within the operating limits of the aircraft at those heights.

Search and Rescue – was always a preoccupation. When an aircraft is forced to land in the jungle the main difficulty is in pin-pointing the wreckage. I was for some time a Member of a Board of Inquiry investigating the crash of a twin-rotor Belvedere in which nine men were killed. It was extremely difficult to spot the wreckage

through the small hole in the jungle canopy, even when the approximate position was known. I had the novel experience of being lowered 90 ft on a winch cable from a Naval Wessex and, after leaving the strop, climbing down a 30 ft rope and then dropping the last 10 or 15 ft onto the fallen trees. Having carried out a survey of the wreckage, I had to march out 6 miles through the jungle in a blinding thunderstorm. Some days later, in the company of an Accident Investigation Branch Inspector I was flown back by Sycamore to within 450 yards of the wreckage. This was achieved by flying down a river so low that the trees overhung the rotor disc on either side and then jumping down onto a boulder in the river bed whilst the aircraft was in the hover. When the investigation was completed, some 3 or 4 days later, having manhandled several tons of rocks into the river to clear some sort of helicopter pad, we made the very tricky recovery by Sycamore.

Some months later we carried out trials with parachutes with the object of perfecting a system of marking a crash site. The idea was to place a parachute attached to a box of rations on a static line in the cabin. If the engine failed the box and 'chute were to be jettisoned at a height of between 20 and 40 ft above the tree tops. The weight of the box was just sufficient to deplc. the parachute. It was quite successful; the ones that were dropped near the crash site lay billowing on the trees and could be seen for miles. However, trials are shortly to be conducted on a crash-indicating radio beacon that will automatically be thrown clear and activated on impact.

PROBLEMS ENCOUNTERED

Generally, as expected during these undoubtedly successful helicopter operations, many problems were highlighted and some still remain to be solved.

Just to mention a few:-

Navigation - was one of our chief difficulties, due to the lack of suitable maps. Jungle navigation, when cloud or tactical considerations often precludes flying high enough to adhere to fixed courses and times, becomes just a question of getting to know the area, mentally orientating the more prominent features and following the line of contours or rivers. Pyrotechnics, balloons, and radio beacons have proved useful for the location of L.Z.s. Night operations were not undertaken except in emergency due to the lack of aids and the risks involved.

Communications - as indicated, HF Single Side Band equipment proved a great breakthrough in this sphere. With a phenomenal range and efficiency, even from ground level in a jungle clearing at the bottom of a valley, it proved invaluable after the first few months of teething troubles. Adequate communication between the helicopter and ground troops was often not possible due to incompatibility of sets and this proved a considerable embarrassment at times. Finally, communications between the pilot's cabin and the passenger compartment was found to be highly desirable. Even so, the problem of language remained if the Ghurka or Malay troops were unable to speak English, for very few pilots spoke these languages.

Weight and Centre of Gravity - unless every passenger and item of freight was weighed on the specially provided (bathroom) scales and the pilot maintained a constant exercise of mental arithmetic there was always a risk of exceeding the limits

of All Up Weight and C of G travel. It is now technically possible to fit strain gauges to all undercarriage legs of fixed or rotary wing aircraft which would indicate the weight of the aircraft and its C of G position prior to take off.

Absailing - Clearly in jungle operations there is a requirement for a safe type of absailing equipment with a drop, and preferably a lift too, of 2-300 ft in order to penetrate the canopy of trees. Although many experiments were carried out we never discovered a really safe method for lowering or lifting men more than 20 to 30 ft by rope or 60 ft by winch. However, we did successfully lower boxes of ammunition, food, radio sets and even tracker dogs on long lengths of lashing tape which we jettisoned as soon as the load was safely on the ground.

Heat Stress - few aircrew experienced heat exhaustion, probably because of the precautions taken. A progressive exposure to the sun until a good tan was acquired gave protection if inadvertently exposed later. Some of the personnel took salt tablets, others none. It is difficult to say who was right, but provided a normal amount of salt was taken with food, there was little risk of heat exhaustion.

If aircraft were left out in the direct sunlight the cockpit temperatures could reach 120°C and skin contact burns could well result. These were prevented by fitting aircraft cockpit covers or blinds, turning seat cushions upside-down and wearing adequate clothing.

Insects and Diseases - strangely enough the least of our worries: yet judging by the chorus of sounds at night the jungle was teeming with animals, insects and reptiles. Apart from mosquitoes, against which nets, "fish-coils" and anti-malarial pills were quite effective, and leptospirosis which was guarded against by boiling drinking water and avoiding stagnant pools, relatively little trouble was experienced. Personnel were at time subject to minor stomach upsets and one near epidemic of hepatitis which was said to be due to water contamination, but otherwise kept surprisingly fit. This reflected credit on personal hygiene and showed the value of the jungle survival training given to all aircrew at the Jungle Survival School in Singapore.

In Conclusion - there just isn't time in a short talk to describe all the many and varied activities undertaken by RAF helicopters in Borneo. So - having given you some of the background picture and a sketchy outline of one or two of the tasks, I would sum up by saying that in this type of terrain and under very testing conditions the helicopter again demonstrated its unique abilities and extreme versatility. The enormous advances made over the last few years have made even the quite sophisticated aircraft that we finally operated in Borneo seem quite embryonic. The achievement and capabilities that I have only had time to hint at, therefore, represent only the first faltering footsteps of an infant prodigy whose potential is only now being tentatively probed and whose future is undoubtedly assured.

DISCUSSION

Brig.Gen.Lauschner thanked Wg Cdr Eley for his interesting review of operations under extremely arduous conditions. He asked what was the nature of enemy fire-power in Borneo. Wg Cdr Eley replied that the enemy forces were armed principally with rifles, light machine guns and mortars, mostly of East European origin.

ROYAL NAVAL EXPERIENCE WITH HELICOPTERS OPERATING FROM COMMANDO CARRIERS AND AS PLANE GUARDS

by

Lt Cdr P.J.Williams, RN

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RESUME

(a) Principe fondamental du Porte-Avions de Commando

(b) Le Porte-Avions de Commando et ses possibilités

(c) Hélicoptères embarqués; aspects divers de la sécurité en vol

(d) Utilisation de l'Equipage

(e) Opérations sur le pont d'envol

(f) Protection diurne et nocturne d'avions par hélicoptères

ROYAL NAVAL EXPERIENCE WITH HELICOPTERS OPERATING FROM COMMANDO CARRIERS AND AS PLANE GUARDS

Lt Cdr P.J.Williams, RN

Before discussing Royal Naval experience in operating helicopters from Commando Carriers I think it would be helpful to explain what the British understand by a Commando Carrier and to suggest the types of operation to which it is best suited. Without such explanation I thought it might be difficult for you to relate our experience to our progress and difficult for you to reflect on the future.

Various operations in the nineteen-fifties demonstrated to the British Government that a concept which joined helicopters and soldiers together on board a ship would be an efficient and effective method of dealing quickly with limited military tasks over a wide area. So by 1960 two light carriers, no longer suited to the operation of heavy jet aircraft, had been allocated to the new task. Royal Naval helicopters were specially prepared for the new role, which was at variance with their usual anti-submarine work, and the Royal Navy's own "sea soldiers" - the Royal Marine Commandos - were chosen as Britain's sea borne and heliportable, quick reaction force.

As would be expected considerable fighting efficiency is achieved on board a Commando Carrier when the Royal Navy helicopters are continually operating with one particular unit of the Royal Marines: however it would be wrong to gain the impression that this concept is entirely dependent for success upon highly specialised units. Any helicopter force with any military unit is capable of effective operations from a Commando Carrier. To this end Royal Air Force and Army helicopters periodically embark in the Commando Carriers to operate with units of the British Army.

The type of operations to which the Commando Carrier is best suited is of the "Brush Fire" variety where quick reaction creates the correct balance of power necessary for a recognised Government to maintain control and restore law and order. Actual examples of such employment were the Kuwait crisis in 1961, the rebellion in Brunei in 1962 and the Malaysian confrontation with Indonesia which has only recently ended.

For the purposes of this presentation the Commando Carrier is being considered in isolation in order to concentrate on various helicopter operating aspects. In reality the Commando Carrier comprises the spearhead of a composite force which is capable of providing air superiority over the battle area, of screening itself against submarine attack and of carrying the additional armour, troops and logistic support necessary for a military build up.

Britain has two Commando Carriers, the "Albion" and "Bulwark". Both are of the same class and both have been extensively refitted to meet the requirements of military

helicopter operations. All the original heavy fixed wing launch and recovery equipment has been removed and the resulting space used for additional military accommodation. The carriers have an endurance of over 5000 miles at 20 knots and each is equipped with eighteen helicopters. Each has full living accommodation for 750 soldiers but the number carried can be increased to over 2000 men for short periods. One of the great advantages of using an ex fixed wing carrier for this task is that all the hangars and maintenance facilities remain intact and none of the aircraft have to remain on deck during non flying periods for servicing.

This arrangement has the added advantage of allowing the military to use the "flat-top" as a sports arena and so keep fit. One of the biggest problems facing the military commander in a Commando Carrier is keeping his men in top physical condition during extended periods at sea.

The ship carries its own landing craft for a variety of support tasks. It also has motorised rafts for landing heavy trucks which are beyond the lifting capacity of our present helicopters.

The Carriers have retained all their radar equipment and the operations rooms originally used for controlling fixed wing activities.

In consequence the control of helicopters between the ship and shore is positive both by day and by night and in all weathers. The ship is also equipped so that the helicopters can be recovered to the deck in blind flying conditions.

An embarked military unit is equipped with Land-rovers and a variety of anti-tank and other guns up to and including 105 mm howitzers all of which are helicopter transportable.

These are stowed either on deck or in the hangar depending on flying requirements and all this equipment is maintained in good condition because the extensive aircraft workshops are available to the military mechanics.

Mechanical failure of military equipment ashore is normally more readily rectified by flying the equipment back to the ship rather than attempting field repairs. The carrier has its own hospital equipped with an operating theatre, dental surgery and wards with twenty beds.

In addition, operational arrangements are immediately available to expand the medical capability to two theatres and 100 beds as the wounded are brought from the battle area by helicopter and quickly routed via the aircraft lifts and through special wide doors to the hospital. Normally the ship carriers two doctors and a full supporting medical staff. Feeding and domestic facilities for the combined sea air and land force present no great difficulty to the ship since the total number of men on board is normally not much greater than the number originally required for fixed wing operations.

The helicopter used on board the Commando Carrier is the Wessex Mk 5. This helicopter is based on a Sikorsky design but has been re-engined and modified to suit British requirements. The power in the Wessex 5 is provided by two free power turbine engines and these give the aircraft a much better overall performance when compared with the original piston engined American S58. The Wessex 5 has a full single engine capability

throughout all normal phases of flight, the only exception to this ability occurring in very hot and high conditions with the helicopter hovering at full all-up weight. It may be of interest to note here that with the introduction of turbine power plants into Naval helicopters came the opportunity to implement a long standing intention; that being, to remove the need to carry high octane gasoline on board carriers.

The Wessex 5 is a conventionally arranged single rotor helicopter with 2 pilot positions forward and a rectangular cabin, for up to 14 passengers and an aircrewman, below and behind the pilots. There is no reasonable access during flight between the two compartments. The cabin has only one door on the right side and this is a restricting factor when considering the speed at which troops can be embarked or disembarked. It is expected that future helicopters in this role would have doors on both sides with the troop seats outward facing down the centre of the cabin. Apart from the operational advantages of such an arrangement it is thought to be much safer during a forced landing at sea.

Much thought has however been given to flight safety in the Wessex 5 since the helicopters of the Commando Carrier spend a considerable amount of time over water with relatively large numbers of passengers on board. Apart from the single engine performance already mentioned, the Wessex 5 is fitted with flotation equipment which is packed on the wheel hubs and inflated when required. It is fitted with very large windows on the left side for easy exit and all escape routes from the inside of the aircraft are marked by flourescent hand rails to aid passengers when submerged or escaping at night. Each passenger has a properly stressed seat and wears a lap strap. He is not required to wear any protective headgear although the aircrew wear normal flying helmets. Troops wear specially designed lightweight life jackets when flying over the sea.

However the most significant contribution towards passenger flight safety is the inclusion in the crew of an aircrewman who is carried at all times. He is responsible for all aspects of passenger control and safety. All aircraft are fitted with rescue hoists and the crewmen are all trained in search and rescue techniques.

Since the Commando Carriers carry only one type of helicopter it is necessary for that type to be capable of various roles. Fortunately the Wessex 5 is versatile and apart from normal troop carrying it is used for crane work, search and rescue, air ambulance, with up to 7 stretchers plus a medical attendant, and for parachuting, a technique used with pathfinders at night.

Also it can, very quickly, be armed with a variety of weapons which include machine guns, rockets, wire guided missiles and illuminating flares. To complete the description of the Wessex 5 helicopter I think it is only necessary to mention that it is well instrumented and well stabilised, this latter point being of marked interest when considering aircrew fatigue.

The main aircrew problems facing the aviation command during any extended operations are fatigue and availability. Current technical reliability permits a high percentage of helicopters continually on line and so military planning must take close account of the physical capabilities of the pilots. Squadron aircrew complement is planned at two pilots per aircraft, a total of 36 for an 18 aircraft squadron and utilisation is reckoned at 6 flying hours per pilot per day. Calculations on this basis will show

that the ability of the aircrew to satisfy military requirements will depend largely on two main points

(a) The range of shore operations from the ship.

(b) Whether one or two pilots fly in each aircraft.

The two points are closely related. On straight forward daytime operations with one pilot to each aircraft and with the ship-to-shore distance not exceeding 30 miles sufficient sorties, both logistical and tactical, can be flown to satisfy all usual military requirements. The question of range from the carrier is most important, not so much as might be imagined because of the fuel to military payload ratio, but because of the frequency with which the helicopters can be used. Over a 15 mile radius of action one aircraft achieves 5 sorties every 2 hours, over a 70 mile radius only one sortie every 2 hours. Viewed with 18 helicopters over an 8 hour period the short range offers the military 360 sorties, the longer range only 72.

The decision as to whether one or two pilots should crew the helicopter is related to both flying and operational conditions. The rapid expansion of the Royal Navy's helicopter activities in recent years has resulted in a preponderance of young, relatively inexperienced pilots and in their guidance much stress is laid upon the responsibilities of aircraft captaincy and the need to inspire the many and various military passengers with complete confidence in the aircrew. To this end it is usual to fly a crew of two pilots for:

(a) Night and instrument flight conditions.

(b) Aiming and firing weapons.

(c) Areas where there is know to be ground fire and the wounding of a pilot is likely.

(d) On extended flights where navigation is expected to be difficult.

The only other consideration of account when discussing Commando carrier aircrew is pilot and aircraft availability when, for some overriding tactical reason, it is decided to establish an air base ashore which is divorced from immediate carrier support. Under such circumstances, where aircrew and maintenance ratings are under canvas and beset with numerous domestic and technical problems, a reduced availability must be expected. Royal Navy experience in the problem of whether or not to establish aircraft ashore now clearly indicates that tactical daylight operations from a forward air base present no particular difficulties but there is rarely any advantage in keeping aircraft ashore at night.

The keystone of efficient and safe Commando carrier operations is the organisation of the flight deck. And this applies not only to the obvious activities but also to the the detailed support routing required to ensure that the correct men and stores arrive on the flight deck in the right order at the right time.

The Flight deck is divided by a red line into a Flying Area, which includes the aircraft lifts, and an Assembly Area. No military or their stores are allowed into the flying area except under the positive control of marshallers and guides. The influence of the guides does in fact extend beyond the flying area but this is purely to ensure that the military do not become lost within the ship.

The flight deck is controlled from a position in the bridge overlooking the complete deck and the controlling officer is in radio contact with all his flight deck team.

So that the various responsibilities on the deck are easily known the men wear different coloured jerseys. For instance yellow is for marshallers, green for guides and various other colours for the different technical trades, the refuelling crews, the crash crews and armament parties.

The flight deck has nine helicopter operating spots, of which eight are used and one is kept spare for emergency. For a pre-planned assault 14 helicopters can be ranged close together but this arrangement can only be used for take off.

When an assault is in full swing the aircraft are kept running for hours on end and the aircraft are fuelled and loaded with the rotors still turning so that the pilots may thus be changed in readiness for the next flight. A normal turn round would be about 4 minutes.

That concludes my outline picture of the Royal Navy's current operations with helicopters embarked in Commando ships but before going on to discuss briefly helicopter planeguard I would like to comment that I have not attempted to detail the trail of experiences which have resulted in our present assault capability but only to show how we are doing the job, in the hope that it will provide a suitable operational background for your future discussions.

Search and rescue at sea or, more specifically, "planeguard" is a straightforward utilisation of a helicopter and I do not intend to elaborate on the basic concept which is essentially to provide a rescue service for fixed wing aircrew during the launch and recovery stages of deck operations. However there are two recent refinements in the task of planeguard to British carriers with which you may not be familiar.

Initially helicopter planeguard was a daytime only capability because without visual reference the helicopter could not hover, and clearly, no such reference is available at sea at night. However the anti-submarine helicopter has a very real need to hover at night and the doppler flight control system developed to satisfy this requirement has been adapted to night planeguard so giving it a complete 24 hour capability.

Another development is the addition to the planeguard crew of a free diver whose task is to give assistance to fixed wing aircrew when in the water. This may be as a result of ditching or a low level ejection but in either case the rescue helicopter positions itself alongside the downed aircrew and the free diver jumps into the sea to give assistance.

The types of assistance of which the diver is capable are

(a) Clearing unconscious or entangled aircrews from an aircraft which has gone into the sea during land on or take off and giving immediate mouth to mouth resuscitation to a survivor whilst still in the water.

(b) Clearing aircrew from enveloping parachutes after low level ejections.

(c) Operating the life saving equipment of unconscious or injured aircrew.

(d) Marshalling survivors in the water into the appropriate type of rescue strop or net for winching up into the planeguard helicopter.

DISCUSSION

Capt. Buckley asked what cable length was available in the winch gear of the RN helicopter. **Lt Cdr Williams** replied that normally 60 ft were available, but that this could be extended to 300 ft for over-jungle operations. **Wg Cdr Iley** expressed surprise at the height from which the diver appeared to be jumping into the sea in one of the photographs shown: it appeared to be of the order of 25 ft. **Lt Cdr Williams** replied that this was routine procedure and **Capt. Buckley** added that USAF para-rescue men were trained to jump from 35 ft.

Wg Cdr Fryer enquired whether it was possible in the noisy environment of the helicopter to re-brief assault troops if an in-flight change of operational plan was indicated. **Lt Cdr Williams** replied that this was possible. At all times the crewman and the military troop leader on board each helicopter were connected to the aircraft inter-communication system.

Lt Cdr Hill enquired about the efficacy of flotation aids in RN assault helicopters. In his own service there had been much concern recently with the problem of the provision of flotation not merely for the lightly-clad passenger but for the heavily loaded and armed man. **Lt Cdr Williams** replied that adequate buoyancy was provided by life-saving waistcoats, which were worn by all personnel during over-water flights, and discarded just before touch-down. In addition the Wessex helicopters had buoyancy aids in the form of automatically inflatable sponsons on the wheel hubs and a flotation bag in the rear fuselage. These aids, which weighed a total of 146 lb, would maintain the helicopter in an approximately half-submerged attitude, aiding escape considerably. Unfortunately the attitude lacked full stability.

Brig. Gen. Lauschner commented that aircrew were provided with special protective helmets - were the standard troop's steel helmets at all comparable as impact-protection devices? **Lt Cdr Williams** stated that for in-flight communication with non-crew members only normal head-sets were available. **Capt. Ireland** commented that military helmets were of little or no crash-protection value. There was need to develop helmets with both ballistic and impact protection. **Capt. Perry** stated that the British Army was currently assessing a one-size passenger helmet of crushable material for passenger impact protection. **Capt. Buckley** stated that USAF rescue personnel in Vietnam would not wear protective helmets when being winched - they insisted on being able to listen for enemy movement.

RAF SEARCH AND RESCUE OPERATIONS

by

Wg Cdr M.W.B. Watson, MRSC, LRCP, DObstRCOG, RAF

Medical Centre, RAF Leconfield,
Beverley, East Yorkshire, UK

RESUME

1. Organisation

Plan de recherche et de sauvetage du Royaume Uni.

Tâche essentielle - sauvetage du personnel après accidents aériens civils ou militaires, sur terre ou sur mer.

Tâche secondaire - aide aux autorités civiles dans la mesure où le permet l'exécution de la tâche essentielle: navires ou plateformes de forage de pétrole en détresse; marins malades ou blessés; incidents côtiers - nageurs, chutes du haut de falaises, accidents de bateaux à proximité du rivage, cas d'isolement par la marée; ambulance aérienne; aide médicale ou ravitaillement de régions distantes ou isolées; recherche de personnes disparues.

2. Limitations

Moment du jour ou de la nuit ou se produit l'accident - conditions météorologiques et visibilité - distance - vents - poids.

3. Problèmes

Recherche d'un médecin;

Choix de l'équipement médical à transporter;

Mode de transport de l'équipement;

Transmissions - données sur la situation avant décollage communications entre hélicoptère et bateau langage;

Recherche du bateau - identification sur la route de navigation - orientation;

Système de hissage par treuil - direct, ou à partir d'un canot, d'une baleinière ou de la mer;

Choix du mode de traitement du patient: à bord en restant avec lui, ou transfert à l'hôpital par hélicoptère;

Attitude du patient - peur - refus;

Transfert du patient - difficultés posées par son transport à partir des ponts inférieurs, type de brancard à utiliser;

Problèmes posés à bord de l'hélicoptere: vibrations, bruit, exiguïté de la cabine.

4. Choix du Convoyeur

Médecin exercé aux opérations de hissage, ou spécialiste des manoeuvres de hissage par treuil possédant un entraînement de secouriste. Méthodes de formation.

RAF SEARCH AND RESCUE OPERATIONS

Wg Cdr M.W.B.Watson

The Search and Rescue Service is operated in the United Kingdom by the Coastal Command of the RAF and is based on 2 Rescue Co-ordination Centres (RCC's) - one near Edinburgh and the other in Plymouth.

These can be alerted from numerous civil sources and can communicate with foreign RCCs. They direct all operations and have close links with organisations such as the Lifeboat Institution, the Coastguard and the Police.

The helicopter element is only one part of the organisation and consists of 2 single-engined Whirlwind Mk 10 helicopters at each of eight airfields around the coast - the majority being in the East and South coasts - sometimes helped out by Royal Navy and USAF helicopters (Fig.1).

The primary task of the helicopter service is the recovery of personnel from military or civil aircraft crashed on land or sea. The secondary task is to give help to civil authorities in various ways. This includes help to shipping (including offshore oil-drilling rigs) in distress or to personnel on them who are sick or injured.

Many calls for help come from along the coastline where swimmers or boats get into difficulty, or people are stranded by the tide. Cliff falls - often involving serious injury - are quite common. Particularly in winter help is asked for remote areas either to take medical staff to islands or to take supplies to areas cut off by snow or floods.

We are often asked to provide an Air Ambulance Service within the UK at short notice when suitable aircraft are not available from Transport Command and some of the sites - particularly at Hospitals - are inaccessible to fixed wing aircraft.

These requests are usually for a patient going to a special treatment centre such as for spinal or head injury. In general it is not considered worth using a helicopter as an ambulance where a road journey of less than 50 miles would otherwise be necessary.

The police occasionally ask for help too - not just looking for dangerous escaped convicts but for mental patients or lost persons. Recently we picked up an old man who had wandered off from home and was found on the moors, exhausted, 2 days later.

Each flight seems to have a slightly different role due to their geographical position. At Leuchars in Scotland, the accent is on mountain and island work, at Acklington mountain and coastline, at Leconfield on fishing trawlers, at Coltishall on coastline incidents and some trawlers, at Manston - Air Ambulance, holiday makers

and channel shipping, at Thorney Island and Chivenor - coastline and at Valley - mountain work at Snowdonia.

Perhaps the best way to explain the job I know best is to given an example of a typical mission - which fortunately is not to crashed aircraft but more commonly to a sick or injured seaman on a trawler.

On receiving a call for help from a trawler, perhaps 100 miles out to sea, the Rescue Co-ordination Centre order off a Search and Rescue Shackleton aircraft from a Coastal Command airfield. This aircraft should be on its way to the scene of the incident within 20 minutes. At the same time the Co-ordination Centre alerts the helicopter flight nearest the incident, giving them all the available information which normally includes some idea of the condition of the casualty on the trawler.

The flight on the Station calls for the Service Medical Officer, who decides whether he should go with the crew of the helicopter to render immediate medical aid and supervise the transfer of the patient to hospital. This nearly always means that the M.O. has to go as the information from the ship is so vague.

The flight also warns the hospital at which the casualty is likely to be landed, and the police in that area, who prepare the landing ground by the hospital and prevent an influx of sight-seers at the critical moment. Each hospital in our area has a designated landing site (usually a nearby sportsfield) which is inspected regularly and photographs and details of each are carried by the navigator in the helicopter.

The waiting period for the helicopter crew and M.O. then starts, for it may be some hours before the Shackleton locates the trawler, having first to investigate each radar contact in the area visually to find the right ship.

As soon as positive identification has been made, the Shackleton aircraft signals the Co-ordination Centre which orders the helicopter to "Scramble", giving the position of the Shackleton. If this position is within range the helicopter sets off, at first using the Decca Navigator and later being homed direct on to the trawler by the Shackleton. With full fuel and crew of three plus the Medical Officer and all the gear carried for the Search and Rescue role the helicopter is at maximum take-off load of 8000 lbs.

Maximum conservation of fuel is essential as it is impossible to estimate beforehand how long the helicopter will have to remain with the ship whilst the casualty is made ready for transfer to the aircraft.

In some cases this may only take a few minutes - on one occasion the casualty suffering from pneumonia was found walking on the deck and it only took the winchman a few minutes to lift him with a double strop.

On the other hand, the casualty may have a broken limb or severe head or internal injuries so that some medical attention may be necessary before he can be strapped into the Neill-Robertson stretcher, which is our standard equipment, and lifted into the helicopter.

Absence of a suitable area on the ship for landing the winchman and M.O. may waste time - many trawlers are too small and too cluttered with masts and rigging to make direct winching to the deck possible.

In this case the winchman and M.O. may have to be dropped in the sea alongside the vessel and hauled aboard. They prepare the casualty for lifting, then lower him into a dinghy or life raft trailed astern the vessel and winch him up from there.

I should say we do wear suitable clothing for these escapades and everyone wears a waterproof immersion suit and warm underclothes. The suits are buoyant and all crew wear life saving jackets as well.

As a result of all these hinderances allowance is made for a stay of 30 minutes with the vessel. Even when the vessel has a clear area to get the winchman on board casualties have the habit of occurring in very stormy weather, and the ship remains far from steady.

Once the casualty is aboard the helicopter all that remains is to fly him to the nearest shore hospital and keep him as comfortable and alive as possible on the way.

The Shackleton usually accompanies the helicopter back to land, giving some comfort to a crew almost always out of radio touch with the shore and acting as a radio relay station, so that the hospital finally selected may be told the expected time of arrival and the police may make final arrangements for the landing ground. This often involves positioning vehicles to illuminate the touch-down point, since the operation which may have started initially during the morning is by this time running into night.

This description of a typical mission as you see has already explained some of the limitations and problems of the task.

The time of day is one, as the Whirlwind cannot maintain a hover without a horizon to work from. Where there are lights along a shore or a little light along the horizon from the setting sun it may be possible for the pilot to hover over the ship for winching, but this rarely is the case at night. Landing at night is not such a problem with the help of the police and prior knowledge of the general layout of the hospital landing sites from pictures taken by day.

Many successful missions have been carried out at last light and sometimes when the light is nearly gone, there may be just time to put the doctor down to the ship and leave him on board to give treatment rather than come back with the helicopter.

Another way round the night problem which we have used, is to take the doctor to the nearest lifeboat station and there lower him to the shore. The helicopter carries flares, and a good landing light allows landing on the shore whence the doctor can go by lifeboat to the ship. The helicopter awaits his return with the patient to continue the journey to the hospital by air.

The range limitation in our area has been reduced recently with the arrival of the oil drilling rigs scattered around the North Sea. Previously any ship much over 70 miles away was unreachable, but now we can almost double this range if there is a suitable oil rig for refuelling on the way to the ship and on the way back. We did

such a journey to a trawler last month by refuelling on the American and Norwegian oil rig "Ocean Viking" 60 miles off the coast.

Is there room for a Doctor to go at all? He may have to be left behind as in the case of the disaster to the Sea Gem oil rig 18 months ago. One non-essential person on board means one less survivor can be picked up from the sea.

One has to find a doctor too! Not all the helicopter flights have service medical officers and there may not be a doctor available or willing to go. In such circumstances the crew will have to do the best they can. On my Station there are two well-above-average nursing attendants who have volunteered to go if a doctor is not available. They can carry out regular training in winching and dinghy drill with the aircrew and have been on operational trips.

What Medical Equipment does one take? We use a simple hardwearing canvas bag in which we put the drugs and equipment which experience tells us are most likely to be needed and modify this if we know that something special is needed for a particular incident (Figures 2 and 3).

For example, we took 2 pints of Group O Rh, Negative blood from the local hospital to a Dutch seaman with haematemesis from bleeding duodenal ulcer. We also take an oxygen resuscitator if this is likely to be required. This is fully automatic and adapts itself to differing vital capacities of adults and children.

The medical bag is not carried by hand. By using our bag clipped to the hook of the winch cable, the doctor's hands are left free to help ward off any obstruction coming his way or winching by a form of bosun's chair to an unsteady ship (Fig.4). The doctor always should wear a protective helmet, as it is not at all uncommon to get a bang on the head from some part of the ship on the way down and up.

Communication with the ship in order to get some idea of what sort of case we are going to is a problem. The situation is usually described as a "Sick seaman" or "Injured seaman" on a motor fishing vessel. This is a typical request and further details are often not available making it very difficult to know what equipment to take. The request for a helicopter is not always made by the ship to the Co-ordination Centre but is relayed first to a doctor near the shore radio station who is in my opinion often not the most suitable to give advice.

I think that the radio doctor should be an experienced Port Medical Officer or the doctor who is being asked to go with the helicopter and who should make the decision on the type of aid needed. The Junior Casualty Officer at the nearest hospital who happens to be on call (sometimes with a limited knowledge of English) I think to be quite unsuitable and we have been let down on several occasions by this system.

We have had a very wide selection of cases to collect since I have been at Leconfield as you can see from this list:-

RESCUE AND CASUALTY TRANSFER CALLS

Aircraft Accidents	*Type of Incident*	*Injury*
Hunter	Failed escape	Fatal
Lightning	" "	
Sea Hawk (German)	Crash	
Varsity	Mid-air collision	
Light-aircraft (civil)		
Meteor	Collision-ejection	All fractured lumbar or dorsal spine
Buccaneer	Double ejection	
Jet Provost	Ejection	
Hunter	Ejection	
Tiger Moth	Overturn	
Auster	Descent into sea	
Air Ambulance	*Type*	*Number*
Transfers to special treatment centres	Fractured spine	2 (one cervical)
	Fractured skull	3
	Status asthmaticus	2
	Coronary thrombosis	1
	Fractured jaw	1
	Chest injury	1
	Exposure	1

Shipping Calls

Small vessels and trawlers	12 calls	Two "called off" in flight. Other included coronary thrombosis (2), drowning, epilepsy, fractured pelvis and spine, respiratory obstruction, urinary retention, fractured hand and shoulder, fractured maxilla, perforated duodenal ulcer.
Large vessels	3 calls	Poisoning by fumes, haematemesis and hand injury.
Diving vessel	1 call	Decompression sickness (fatal).
Oil rigs	2 calls	Drowning and abdominal emergency.

It is sometimes possible to check on the situation before take off by radio link through the shore station to the ship direct from the helicopter crew room. After take off, communication between the helicopter and the ship is virtually impossible as we have different radio frequencies, so we need a third party to act as a link. The Shackleton can sometimes do this and give some idea of what is going on, but by then, it is too late to change your equipment. Language differences may make communication more difficult not only to the ship but also with the patient and we have picked up Dutch, Danish, German and Polish seamen.

Sometimes we have a problem finding the ship. If it is nearby we take off immediately and get to the area before the Shackleton does. The ships are very bad at letting you know which one wants you. If you fly close to a trawler, all on deck wave and you think you have the right trawler, but they are just being friendly. So have to go round each one trying to read the name to be sure.

As already explained getting on to the ship at all may be difficult and direct winching off may not be possible. In such a case the doctor may have to remain on board until the ship reaches port, as in the case of the diver with decompression sickness, with whom I had to remain in his compression chamber.

The patient's attitude to being winched up into an aircraft varied a lot and you can understand the patient being a bit apprehensive on seeing a figure approach from the air, tie him into a straight jacket and whisk him away on a wire to the machine hovering above. The patient may even refuse to come after your efforts to reach him and may not be as ill as was suspected. On the occasion on which I went via helicopter to a lifeboat in a gale I was very glad the patient (with injured thumbs) refused to leave her ship as after three hours in the lifeboat I am sure I was sicker than she was!

Getting patients up from the interior of a ship is often difficult especially if they have an injured back or are heavily built and tucked away in a bunk below decks. Tying the patient into a Neill-Robertson stretcher in a confined space and then wriggling him through the corridors and gangways to the deck of a little trawler requires a lot of strength and it is impossible to carry on with any sort of treatment in these circumstances.

The helicopter just cannot hang around for long whilst the decision is made on what to do and by the time we reach the patient first aid treatment is not really relevant. The best thing to do in nearly every case is to get the patient tied into the stretcher and winched up to the helicopter, and then to get back as soon as possible.

Vibration in the aircraft is not much trouble except perhaps on starting or stopping the rotors. For example, if a patient has to be taken in or out of a helicopter on the ground it is best done whilst rotors are running. A patient with a fracture of the cervical spine would be shaken unreasonably if in the aircraft during "wind-up".

Communication with the patient is very difficult in the aircraft because of the noise and although we do provide ear muffs, one of the patients told me that his trawler made more noise, so he didn't want them. Auscultation is impossible.

I was asked to discuss who should go on a rescue operation. Should doctors go who are trained as winchmen or should all the winchmen be trained as "super firstaiders".

I think that a compromise is the answer and we find that this works very well. The doctors must do regular training in dinghy drill and winching and the winchman must have regular First Aid training. If a doctor is not available, nursing attendants (particularly those with aeromedical experience in casevac role) can be trained in lieu. We think that this arrangement is very worth-while as it takes the responsibility of looking after the patient from the aircrew - they have enough else to worry about.

We think that the winchman - and the rest of the crew too - should be taught extra First Aid for often they are on their own. Most of the winchmen are relatively old, experienced, very conscientious - and keen to learn all they can to improve their First Aid. On a small detachment such as ours this is done by regular discussions in the crewroom and in flight with the Medical Officer on training trips. Films on First Aid, resuscitation and cardiac massage are shown regularly.

We don't encourage aids to resuscitation such as plastic airways or Brooks apparatus lest personnel get the idea that mouth to mouth resuscitation is impossible without them. But if the patient is vomiting and one is full of sea water as well it is difficult to bring oneself to do it direct. The automatic resuscitator is a big morale aid to the crew apart from its usefulness where cardiac massage is needed at the same time.

The crew do worry about whether they are doing the right thing or whether any mismanagement on their part might make a patient worse. For example, in the case of a man with the fractured Cervical Spine where careful selection of transit height could cut air turbulence to a minimum. In such a case the presence of a Doctor helps to relieve the aircrew of responsibilities for the patient and they appreciate this. We find mutual co-operation very worthwhile and although the incidents are often rather unpleasant at the time there is a great job-satisfaction and the morale of all the crews is extremely high.

I am very grateful to have had the privilege of joining such men during my time with 202 Squadron. Having given you a rough idea of how we work, I would like to leave the remaining time free for discussion and to hear your views.

The discussion following this paper appears on page 36.

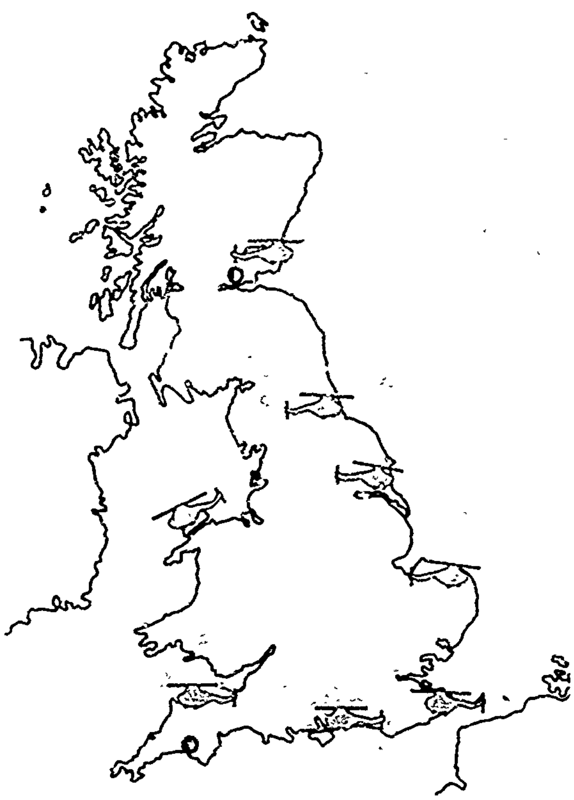

Fig. 1 RAF search and rescue organisation

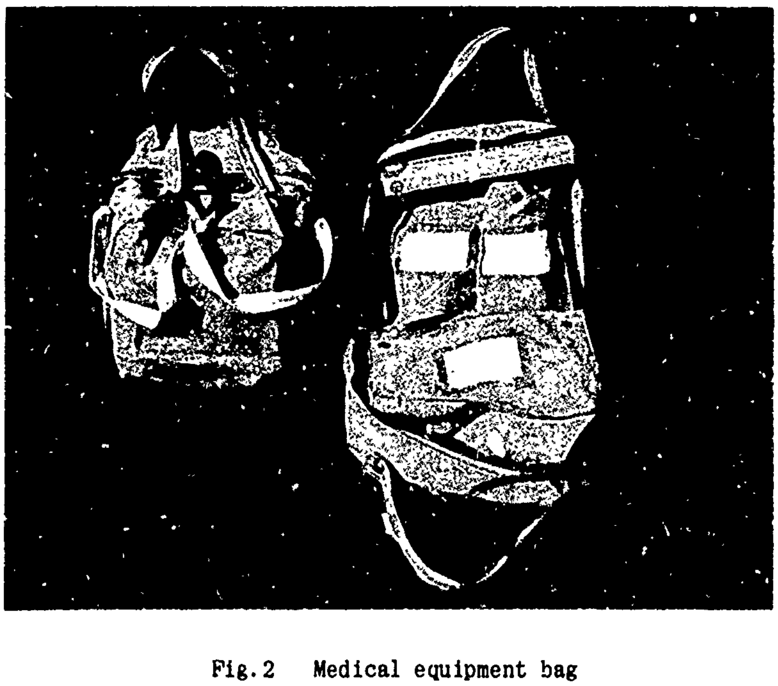

Fig. 2 Medical equipment bag

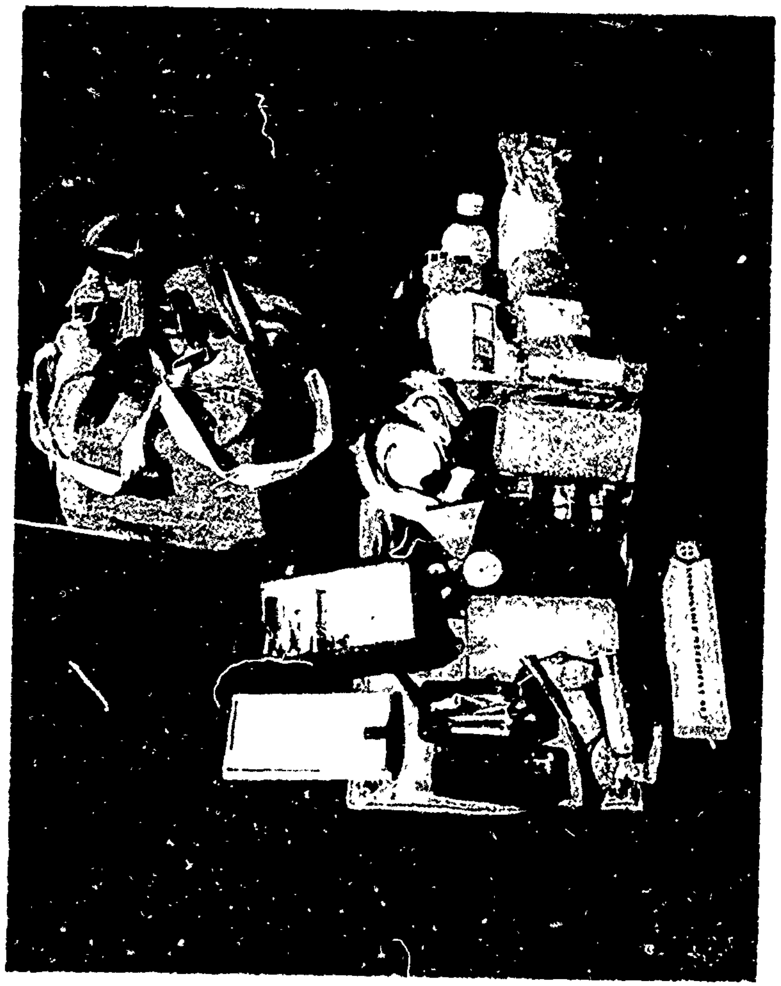

Fig.3 Medical equipment bag - contents displayed

Fig.4 The doctor and his medical equipment bag

DISCUSSION

Cdr Mackie commented on the value of hearing of Wg Cdr Watson's experience in this field. In his own opinion, the Neill-Robertson stretcher was not suitable for winching purposes – the RN had had a severe case of head injury caused by striking the helicopter in the final stage of winching. He asked whether Wg Cdr Watson felt that the Stokes litter might not be better. Wg Cdr Watson thought that the Neill-Robertson stretcher, although far from ideal, was readily available on ships etc and that the risk of head injury was, in his experience, minimised since the winchman's main responsibility at that stage in winching when the patient was being lifted was to protect the head. Capt Buckley stated that the USAF use the Stokes litter with reasonable satisfaction. He asked whether any nation present had developed suitable flotation aids for such litters. USAF had been working with buoyancy bags for the Gemini support task but early trials had revealed a risk of assymmetric inflation with inversion of the litter. This would be disastrous since the inflation was performed after insertion of the casualty. A manufacturer was working on this problem currently. Capt Ireland commented that the US Navy was at present studying a very promising new rescue net system.

Brig Gen Lauschner asked about recompression chambers for diving casualties such as that mentioned by Wg Cdr Watson. In Germany there was available a light-weight single man portable chamber of limited depth capacity and endurance but eminently suitable for helicopter use.

Brig Gen Lauschner asked about the training of winchmen in first-aid techniques and of doctors in winching drills. Wg Cdr Watson stated that he personally carried out the first-aid training and joined-in with winchman training. He ensured that all SAR helicopter crews on his station were conversant with current first-aid methods. Capt Adams was unconvinced about the advantages of sending a doctor on such missions. Capt Buckley felt that a doctor was often a liability in such circumstances. He had trained 200 to 250 crewmen in the special first-aid techniques necessary in the USAF Rescue and Recovery Service role and was well-satisfied with their level of ability. Wg Cdr Watson replied that in his type of mission the doctor's services were often not necessary but that the paucity of information given by those calling for aid generally meant that it was impossible to judge in advance the type of help required. On small ships there was often a good deal of skilled aid required before the patient could be brought to the deck, let alone winched off.

Col Shamburek asked whether casualties were generally carried in stretchers whilst on board the helicopter. Wg Cdr Watson replied that this was so in his work; he found the stretcher to be an excellent splint to maintain immobilisation of any fracture. Col Shamburek stated that in US Army experience their preference for the prone position for patients meant that stretchers were rarely used.

THE HELICOPTER

A TACTICAL RESCUE OR RECOVERY VEHICLE

by

Captain C.J.Buckley, USAF, MC

Aerospace Rescue and Recovery Service,
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RESUME

La Service Aérospatial de Sauvetage et de Récupération (Aerospace Rescue and Recovery Service) de l'Armée de l'Air des Etats-Unis a trois missions essentielles:

(a) la première de ces missions menées par hélicoptères, et aussi la plus active, est le sauvetage sur une base locale, avec lutte contre l'incendie et opérations de sauvetage sur les bases aériennes tactiques.

(b) Il existe ensuite un service d'évacuation par hissage d'accidentés se trouvant sur un terrain ennemi où la preparation de zones d'atterrissage est impossible.

(c) La mission la plus difficile consiste enfin à aller rechercher des équipages de combat à de grandes distances (équipages d'avions manquant à la suite de sorties opérationelles).

L'auteur étudiera les plans actuels et futurs d'exécution de ces trois rôles.

THE HELICOPTER
A TACTICAL RESCUE OR RECOVERY VEHICLE

Captain C.J.Buckley, USAF, MC

As the largest single user of rotary wing aircraft in the United States Air Force, the Aerospace Rescue and Recovery Service (ARRS) has gained much insight into the tactical employment of these craft as rescue vehicles through support of combat efforts in Southeast Asia. The mere existence of a combat recovery unit has had an extremely beneficial effect as a humanitarian, morale and confidence factor for our aircrews. It fosters a sense of security for both the man and his family at home. The dollar and cents profit from this activity is readily apparent. The cost of basically qualifying one USAF pilot or navigator is approximately two hundred fifty to four hundred thousand dollars. The majority of our tactical combat aircrew personnel come from the pilot or navigator category and the recovery of one of these individuals represents a considerable monetary saving for our country. When one notes that we have effected over four hundred combat recoveries in the past year alone, the dollar value importance of the rescue operation becomes more evident.

The ARRS combat recovery mission profiles extend from the short-range quick reaction crash rescue/fire suppression activity, to the longer range combat aircrew recovery operation. We have also had experience in the hoist evacuation of multiple battle casualties from extremely hostile areas, and in off-shore personnel recovery from the Gulf of Tonkin. A discussion in more detail of each of these various missions will identify the problems which we have encountered with our helicopters and should also serve to demonstrate how effectively the helicopter functions as a rescue vehicle.

The first and busiest of our helicopter missions in Southeast Asia is the local base rescue activity. We rely on the HH-43 Kaman Huskie, a twin rotor, single jet powered, helicopter which is capable of deploying approximately seven hundred gallons of standard CO_2 foam from a Fire Suppression Kit (FSK) suspended beneath it. The twin intermeshing two-bladed rotor assemblies are mounted in a side-by-side arrangement on individual rotor pylons. These are counter-rotating, eliminating rotor torque reactions and providing an aerodynamically balanced rotor system, referred to as a 'synchropter'. This design lends itself to the use of longer rotor blades for a given size helicopter and this produces a much greater lifting capacity per horsepower. In a synchropter, all available power is converted into lift with none diverted for driving a tail rotor. It is this efficient use of power provided by its Lycoming T53-L-1 gas turbine engine that enabled the Huskie to establish a world helicopter altitude record of thirty thousand feet.

This aircraft with a crew of four stands daily alert at most of our tactical air bases, responding immediately to impending or actual disaster upon notification by the primary crash communication net. After flying to a crash site, the two airborne fire-fighter crewman are placed on the ground. Combining both the foam from the FSK and

judicious use of rotor downwash from our helicopter which hovers above them, the firemen are able to cut a path through the fire to the cockpit of the burning aircraft to rescue the periled crewmen. Since they carry only a limited quantity of fire suppression agent, these firefighters make no attempt to extinguish the blaze unless it appears within their capability to do so. As might be expected, an ordinance laden aircraft adds considerably greater risk to this type of mission, and precision timing and close teamwork are essential for its safe, successful accomplishment.

An armor plated version of the Kaman HH-43 helicopter is also used for our second and, I believe, our most hazardous combat recovery activity. I am referring to the hoist evacuation of multiple casualties from acutely hostile areas. Ground combat units operating in dense jungle regions frequently request our assistance in evacuating casualties requiring immediate medical attention. These ground forces may lack the capability or determine that it is not operationally feasible to clear a landing zone to accomplish medical evacuation in the usual manner. HH-43 recovery teams are then called to action.

This helicopter has exceptionally good hover capability in the low density atmosphere at altitude encountered over the jungle highlands of Vietnam. It is held in hover over the top of one hundred fifty to three hundred foot jungle trees while the casualties are hoisted to the helicopter through a small opening in the vegetation canopy. Prior to the actual casualty evacuation, a pararescueman is usually lowered to the ground to act as evacuation controller, expediting the recovery operation and often rendering medical assistance to wounded in the immediate area. It is during the fifteen to thirty minute hover time required for accomplishment of this mission that our aircraft and crew are most vulnerable to enemy ground fire. Repeat performances in the same hostile area are generally necessary to complete the removal of all casualties as the litter capacity of the HH-43 is quite limited. We have encountered considerable difficulty supporting this type activity.

The armor plated HH-43, or F model as it is better known, is also used for aircrew recovery activity within South Vietnam and its near coastal waters. The limited range and single engine vulnerability of this helicopter make is undersirable for use in the combat aircrew recovery mission over North Vietnam and most of the Gulf of Tonkin. However, equipped with a two hundred twelve foot hoist and forest penetrator, (a plumb bob-shaped device constructed with fold-down seat panels and personnel restraining belts, and specifically designed to penetrate easily the thick jungle canopy) the HH-43F has done a most effective recovery job (Figs.1-2). Deployed in pairs, two helicopters will speed to locate the site of a downed aircraft, using both electronic and visual means. If a landing area is available the helicopters will land and deploy pararescue personnel to inspect aircraft wreckage and recover survivors. However, if the terrain is unsuitable for helicopter landing, as is much of the Vietnamese jungle, a hoist recovery will be necessary. The survivor's position must be accurately located, often a time consuming and difficult task. When this has been accomplished, one of the helicopters will hover over the jungle as near to him as possible, and lower the forest penetrator to effect the rescue. The other helicopter will remain at sufficient altitude to observe the area for hostile action.

If the survivor is incapable of assisting in his own rescue or is in need of medical aid, a pararescueman will be lowered from the helicopter to help him and thus expedite the recovery. The pararescueman is one of the most important members of our rescue

team as it is usually through him that the actual rescue is physically accomplished. Approximately two hundred of these highly trained experts in every aspect of survival, are assigned to ARRS units worldwide. As precision parachutists, capable of jumping by day or night into difficult terrain or into any body of water wearing full Self-Contained Underwater Breathing Apparatus (SCUBA), they are unsurpassed. All are mountain climbers and proficient medical technicians skilled in emergency medical knowledge and procedures. If the survivor cannot be contacted or located, the pararescueman may be lowered to conduct a land search of the wreckage and the immediate area. If hostile fire forces his hovering helicopter to withdraw, he is trained to evade and survive on his own until his rescue can be accomplished at a later time and another place. Again, close coordination and teamwork are what makes this operation a success.

Our last and most difficult helicopter mission profile in Southeast Asia is the out-of-country combat aircrew recovery operation. This activity has taken basically unarmed and unarmored rescue forces deep within the land mass of North Vietnam to effect the recovery of downed tactical fighter-bomber crewmen. The rescue vehicle used for this mission is the Sikorsky HH-3E, a twin jet, single rotor, long range helicopter instrumented for all-weather flight and equipped with sophisticated electronic personnel tracking and location devices. Its twin engine reliability afforded by two GE T58-5 engines and a new variable speed hoist with a two hundred forty-six foot cable have extended our jungle rescue capability considerably. Through coordinated prepositioning of our personnel and aircraft to give minimum access distance to projected trouble areas at the time of bomb strike raids, rescue forces can be at the downed aircrewman's position as rapidly as possible. The distance to and from the rescue site is frequently great and adequacy of fuel for the return trip is always of prime consideration. All unnecessary equipment must be removed from these helicopters to reduce weight and conserve fuel. This consideration dictates the deletion of all but a minimum of armor plating protection which is afforded the pilot, copilot and certain vital mechanical elements, and negates the possibility of having any substantial weapons system on board. As a result, we must rely on a very well coordinated fire power support effort ranging from high performance jet fighters for protection from enemy aircraft to slower reciprocal engine powered close air support planes for suppression of hostile forces in the area where the rescue is to be accomplished.

Once the downed aircrewman has been contacted, his ground position identified, and hostile fire in the immediate area suppressed as much as possible, the rescue helicopter moves into a hover position and lowers its forest penetrator and, if necessary, its pararescueman to effect the recovery. Minimum delay must be experienced during this part of the operation as it is the time when the helicopter is most vulnerable to enemy fire. The dual helicopter deployment concept is used on most of these out-of-country missions to add an immediate rescue capability for our own forces should one of the close air support aircraft or the actual recovery helicopter be downed. This precaution has proven its value on several occasions.

One of the biggest rescue problems encountered thus far has been accurately locating the survivor on the jungle floor. Personnel locator beacons will direct recovery forces to the general area of the downed man but actual recovery depends upon visual contact with him. A better visual marking and signalling device is needed to transcend the one hundred fifty to three hundred foot trees and their dense canopy. This would identify the individual from the air and decrease local search and loiter time prior to rescue contact, thus conserving fuel and decreasing exposure to hostile ground fire.

Beginning this year, the Aerospace Rescue and Recovery Service will offer a most effective combat or peacetime recovery team. This team will consist initially of the Sikorsky HH-3E helicopter and the Lockheed HX-130P turboprop long range search and rescue tanker. Through the advent of successful operational air-to-air refueling of the helicopter from fixed wing aircraft, weight and distance are no longer the limiting factors governing the success of a recovery effort. Truly, rescue capability can now be extended to the limits of the globe with a reasonable access time period. The addition of the Sikorsky HH-53 heavy lift helicopter to augment this team yields even greater capability. The increased size and power of this helicopter will permit it to carry larger pay loads or sophisticated weapons systems. Its proposed heavy lift capability of ten to twenty thousand pounds will permit recovery of current spacecraft from ocean landing areas. Air-to-air refueling will afford these helicopters the potential to recover a space capsule similar to the Apollo vehicle and return it to the nearest land mass for ultimate return to the USA via jet cargo transport aircraft.

Looking to the future, we of Rescue envision a V/STOL aircraft as the backbone of our operation. It will combine the hover capability of the helicopter with the speed and range of current fixed wing jet aircraft. When it too can achieve an inflight refueling potential, it will represent the ultimate in all purpose rescue vehicles. Access time will be decreased to the absolute minimum through intelligent deployment of these aircraft on a global basis. Combined with simultaneous development of improved survival and personnel locator equipment, the Code of the Rescueman - THAT OTHERS MAY LIVE - will become a more complete reality.

The discussion following this paper appears on page 44.

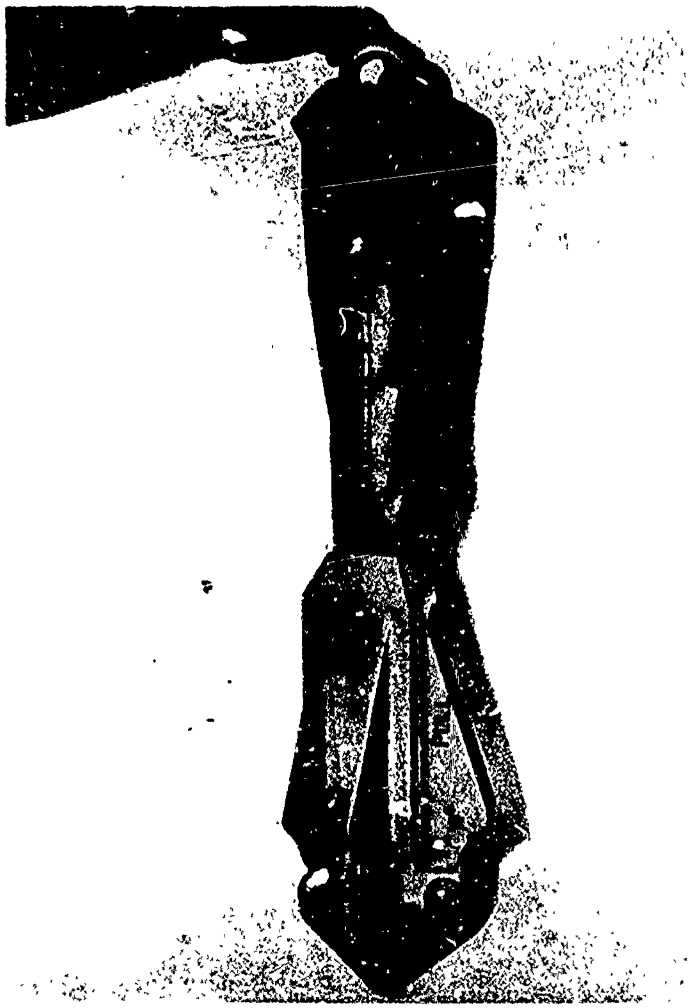

Fig. 1   The forest penetrator - closed

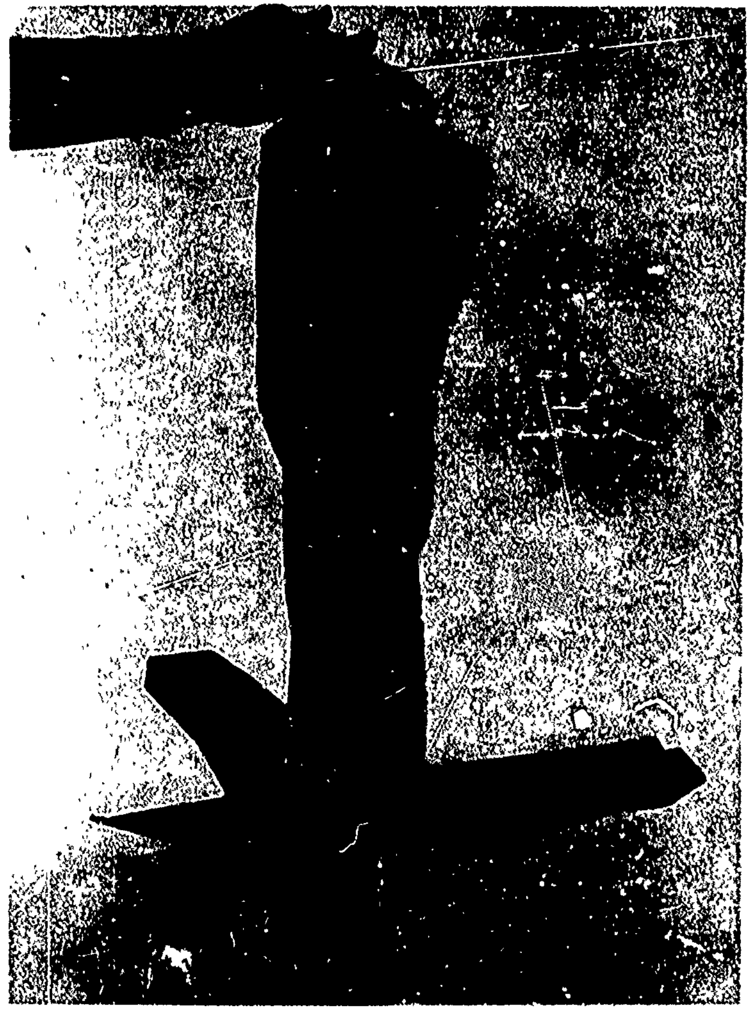

Fig. 2   The forest penetrator - open, showing seat and safety belt.

DISCUSSION

Col Hoogvliet asked about the techniques for in-flight refuelling of helicopters. **Captain Buckley** stated that this manoeuvre was possible up to 10,000 ft but that it was generally performed between 5000 and 7000 ft. Speed was the major problem; the H53 could achieve 185 kt, the HH3E 110 to 125 kt. At these speeds the C130 tanker pilot was presented with an exacting task.

Wg Cdr Eley enquired about the forest penetrator cable length. **Captain Buckley** replied that 246 ft were usable. The rate of winching was rather slow for many circumstances and there were hopes that the time for full-length wind-on could be reduced to some 30 seconds.

In reply to a question by **Brig.Gen.Lauschner**, **Col Malone** stated that he thought that the helicopter in the long-range recovery mission was at least theoretically protected by the Geneva Convention.

Lt Col Lail asked about the utilisation by the 'Husky' helicopters of the Fire Suppression Kit (the 'Sputnik'). **Captain Buckley** replied that only in a very small minority of crash fires had it proved instrumental in saving life. However, as **Col Malone** pointed out, the medical profession should support strongly the development and provision of any device capable of saving life and limb, even if its utilisation might be extremely rare. **Captain Buckley** pointed out that a very serious problem in the airfield crash rescue role was the fatigue and boredom engendered in crews who need to sit in their machines at readiness, day after day for very long hours with a high level of vigilance although in the knowledge that their services will be required very rarely.

Maj.Asdahl asked whether vibration was a major problem in helicopter carriage of casualties; in particular he was interested in the 'synchropter' configuration helicopters. **Captain Buckley** commented that it was rarely severe, although there were some conditions of altitude and load in which it was quite marked.

THE USE OF HELICOPTERS DURING THE FLOOD OF NOVEMBER 1966 IN ITALY

by

Brig. Gen. Dr A.Paganelli, IAF, MC

RESUME

La présente communication concerne la situation dans laquelle s'est trouvée l'Italie en novembre 1966, lors des inondations qui ont ravagé les régions dont le relief est pourtant très différent et où les populations n'étaient pas toutes également habituées à supporter des catastrophes naturelles, d'une telle envergure.

C'est dans ces circonstances que les hélicoptères ont joué un rôle important dans les opérations de sauvetage. Leur intervention est venue à temps, s'est réalisée avec rapidité, ce qui a eu des répercussions favorables sur le moral des populations victimes de cette catastrophe.

THE USE OF HELICOPTERS DURING THE FLOOD OF NOVEMBER 1966 IN ITALY

Brig. Gen. Dr A.Paganelli, IAF (MC)

The flood which struck Italy in November 1966 was of unexpected violence in several regions. To confront the critical situation, all means of available assistance were employed: among those airborne means, helicopters had a particularly important role to play.

I will not dwell on the drama of the situation: the information media - the press, radio, television - gave the world a realistic picture of the event, especially for that which concerned Florence, the custodian of not only Italian, but universal treasures.

The stricken regions present a diverse orography; from the Florentine hills to the Grosseto plains in Tuscany; from the southern slopes of the eastern Alps of Cadore, to the mountains of the Trent region; and finally, the lowlands at the delta of the Po river.

The populations of these regions are variously prepared to confront floods. The inhabitants of the Po delta, used to recurrent floods, are equipped, especially with water-going means to defend themselves, helped by state organizations and by constant surveillance of the level of the river. These people are thus psychologically prepared for the adversities of nature.

The Alpine populations are toughened by the harsh life of the mountains; they are psychologically habituated and physically resistent to nature difficulties.

The populations of Tuscany, from the soft rolling hills of the Arno valley to the plains of Grosseto, living on land re-claimed from the marshes, are also strong and hard-working, but psychologically unprepared for sudden and grave adversities such as that of November 1966.

From this first consideration, we draw the first conclusion: that the populations more exposed to danger are those of Tuscany. For centuries they had never been struck by such a grave natural disaster. Proof of this is that artistic works, as for example, the Crucifix of Cimabue, painted in the 13th century, had never suffered damage from meteorological events as has happened now. However, the strong character of these people and their well-known lively intelligence brought to them the will for reconstruction that has aroused the admiration of all and has given vigor to Italian and foreign volunteers who have offered their useful help.

The work of helicopters in these emergencies has been invaluable.

Helicopters of the Air Force, the Army, the State Police (Carabineers), the fire department and the American command of SETAF were mobilized; organized air reconnaissance gave precise information and the localities which remained isolated were able rapidly to receive first aid.

Tens of tons of essentials were transported by the helicopters; more than 2,000 persons were saved from danger; in some cases, doctors were carried and dropped down in isolated houses to assist persons whom it was not possible to transport.

In all, about 3000 missions were flown. Where the helicopter could not land, persons were lifted from the roofs of houses by a special brace fitting under the arms, with the helicopter hovering; when necessary a member of the crew went down to the house and took care of the attachment of the lifting brace to the injured person, encouraging the timorous.

Even in adverse atmospheric conditions, there was not too much trouble. Any unforeseen obstacle to the assistance operations was quickly overcome. I cite, for example, the inconvenience represented by television antennae which impeded easy approach to the rooftops; the antennae were immediately taken down with the intelligent cooperation of the flood victims, cooperation which facilitated to a great extent the assistance operations.

And here it seems to us that we should point out one fact, perhaps the most important of all the operation in regard to the helicopter: its rapid action, especially in the country and in the small centers, represented a psychological factor of primary importance. It let the inhabitants know that they were not alone; it gave them faith and calmed them; it made orderly work possible; it avoided dangerous collective panic; it allowed invaluable cooperation. The continuous presence of those beneficient "dragon-fly" friends gave courage and will to people who could have abandoned themselves to terror and desperation. This, perhaps, was the least-realized value of the helicopter, a psychological value of inestimable worth.

All this happened principally in the flooded zones of the old Tuscany marsh-land.

In the Po delta, it was a matter of helping to get people on boats and to transport rapidly the sick.

In the mountainous regions, helicopters were able to land and get people in need of assistance on board with more agility. Helicopter assistance in the mountains deserves a separate discourse: in Italy work is being carried out in this sector, especially in the Alpine regions. But this is getting away from the subject of the floods.

Summarizing, we can make the following points:

1. The helicopter, in cases of such emergency as described above, is the most immediate and valid means to employ, that is, of means which are *currently* available. I emphasize the word "currently" since other means, more perfect and safe, will certainly be built by man in the future.

2. The psychological factor has a great importance; a group of people seized by panic can be more dangerous to themselves than a flood. The helicopter, annulling this feeling of isolation, brings serenity and faith once again, facilitating the assistance.

3. No particular difficulties were encountered in assisting a heterogeneous population, unprepared for helicopter assistance.

4. Bad weather, within certain limits, was not a grave obstacle: it put the flight crews to a hard test without, however, the operations being suspended (sometimes the wind reached 80 km/h): but it is obvious that more serious meteorological conditions would have represented limitations to the possibilities of the helicopter.

5. Cooperation with ground vehicles, or amphibious vehicles or embarkations is valuable. In cases of interruptions of communications, air reconnaissance gives indication of the most desirable places to travel, or the most appropriate means of assistance; it informs assistance organization centers, thus making them able to carry out the necessary measures; to indicate the passable areas; regulate the flow of materials; provide for hygienic and sanitary measures. In this field also, it is clear that the perfection and the adaptation of radio communications will more greatly aid air reconnaissance, allowing direct communication.

TABLE 1

(a) Number of helicopters employed . . .	105
(b) Number of persons saved	1796
(c) Number of sick, invalids and wounded carried	996
(d) Number of civilians transported urgently .	479
(e) Fatal accidents – 1 (a person who raised her arms just prior to completion of winch rescue, and fell from the strop) . . .	1
(f) Total live and material cargo weight transported	138,540 kg

DISCUSSION

Wg Cdr Watson commented that he had seen no flotation aids on the illustrations of the helicopters in use in the Italian floods. Were no such aids available?
Brig. Gen. Pagamelli replied that the emergency was such that on the spot improvisation was essential, and that no time was available for the acquisition and fitting of such aids.

Wg Cdr Fryer asked how instructions had been given to the refugees with regard to the clearance of obstructions and the utilisation of rescue aids. Brig. Gen. Pagamelli replied that public-address loudspeakers were carried by many of the helicopters; others had used large placards. Fortunately many of the population in the Po delta owned boats and were able to row into clear areas before rescue.

Brig. Gen. Lauschner asked whether there had been problems with priorities and whether people had wanted to take with them goods and chattels. Brig. Gen. Pagamelli replied that the helicopter rescue was generally restricted to the sick, women and children. There had been little trouble with the populace with regard to acceptance of this principle and few had proved difficult over the question of their possessions.

Wg Cdr Eley asked about wind strengths. He had read in English newspapers about wind strengths of 80 m.p.h. Brig. Gen. Pagamelli replied that these reports would appear to have arisen from failure to convert units; to his knowledge the maximum wind speeds in which they had operated had been 80 km per hour.

OPERATION SKAGERAK

by

Major K.S.Petersen, RDAF
Air Station Vedbaek, Denmark

RESUME

Les hélicoptères S-61 de l'escadrille No.722 RDAF ont été appelés pour venir au secours du ferry "Skagerak" qui coulait à 25 milles de la côte.

Dans des conditions difficiles, avec grandes lames, et par faible visibilité, 69 passagers et équipage ont été sauvés par hélicoptères, et 75 par navires. Le commandant de bord du premier hélicoptère sur les lieux prit le rôle de "commandant sur les lieux" pour toute l'opération.

Des observations sont faites sur les difficultés rencontrées dans ces circonstances urgentes, et les tensions physiques et physiologiques imposées aux sauveteurs et aux rescapés sont discutées.

OPERATION SKAGERAK

Major K.S.Petersen, RDAF

Before I start to describe the "Skagerak" operation, I would like to give you some information about the squadron and its Sikorsky S-61A-1 helicopter.

No.722 Squadron Royal Danish Air Force is the only rescue squadron in Denmark, and we cover the Copenhagen Flight Information Region. We have permanently 3 S-61's on an around-the-clock SAR-duty within this area. They are all under operational control of the Rescue Co-ordination Centre (RCC) at Karup. The squadron itself is based at air station Vaerloese. 90% of our missions take place over open sea, and consist of pick-ups of wounded fishermen, the rescue of people from capsized sailing craft, rescuing downed pilots and rescuing people who have drifted to sea on "air mattresses".

The S-61 is developed from the USN SH-3A, which is used by several forces in the anti-submarine role.

The major differences are:

1. Fuel capacity is increased to 6,200 lbs which allows about 6 hours flying time.
2. Bigger sponsons, not only for emergency landing, but also for shut-down on water in waves up to 2-3 feet.
3. A higher tail cone.
4. Two batteries for start-up independent of ground supplies.

Normal grossweight 19,100 lb. SAR overload 21,500 lb.

Maximum cont cruise 120 kts.

Normal cruise 100 kts.

Max. range 650-700 NM.

With bucket-seats installed there will be room for 25 persons on board, including crew.

Max. altitude 10,000-14,000 feet depending on weight.

SAR crew: 2 pilots
1 radio operator
1 hoist operator
1 rescue man.

Occasionally on special rescue missions a doctor will take part.

Special equipment:

Automatic stabilisation equipment

Decca MK8 A with roller map

Sarah type R625

IFF/SIF APX 25.

UHF/ARC 34 (225-399.9 m/c) with PV/141 which gives a homing capability in ADF position on any transmission with the "hover" indicator in mode "H".

HF618T – 28,000 channels – 2 – 29.999 Mc/s.

Radiocompass ADF 72 with homing capability on 2182 kc.

Radar altimeter APN 117.

Types of hoist operations performed are single, double and stretcher-lifts.

OPERATION SKAGERAK

After this short introduction to the squadron and its equipment, I will continue with the operation "Skagerak", the greatest mission ever required of the Danish rescue organisation.

The 7th of September 1966 was a showery and stormy day with wind speeds of 30-45 kts from the west, ceiling around 2000 feet, visibility of 5 NM and waves of 20 ft to 30 ft. The RCC at Karup received, at 10.37 hrs Z, information that the ferry "Skagerak" was leaking at a position of 5735N-0902E (approximately 25 NM from the coast of northern Jutland). It was on its way from Kristianssand (Norway) to Hirtshals (Denmark) and was sending distress signals. The SAR helicopter at Aalborg was scrambled immediately, and within the next 20 min the rest of the SAR helicopters were scrambled and further helicopter assistance was requested from the squadron in Vaerloese. Furthermore, RCC requested assistance from Norway, Germany, and Sweden. At 11.12Z the SAR helicopter from Aalborg arrived in the area, and the pilot reported that the ferry had launched all its liferafts and wooden lifeboats and that the situation appeared to be very serious. They started right away to pick up survivors. The pilot in command of this first helicopter was ordered to stay in the area until the rest of the helicopters arrived. He was also appointed "On-scene Commander". When he got a couple of ships in sight he directed them towards the disabled vessel.

Meanwhile arrangements were made for the landing and unloading of survivors at a small grass airfield in Lønstrup, which was the closest point on the shore from the ferry. Also closing of roads to normal traffic was ordered, so that the ambulances could have a "free way" for their approximate 15 km drive to the nearby hospital in Hjørring. Ambulances and doctors from the whole area were called to give assistance and the hospital was prepared for the expected enormous invasion of more or less injured survivors. Refueling facilities were made available at Lønstrup airfield.

At 11.25Z it was reported that all passengers had left the ferry. False information was received at 11.36Z saying that the ferry had sunk. This information was immediately

corrected from the helicopter. Owing to the strong head winds the 2 other SAR helicopters and the 2 extra helicopters, which had been sent from the squadron, did not arrive on the scene until 12.40Z to 12.49Z.

The first 18 survivors were landed in Lønstrup at 12.55Z. Until now it had not been possible to get information either from the ferry or the owners how many persons were on board the ferry, but at 13.04Z information was given that there were 170 people on board. After completion of the mission; the final figure was 144 persons. At 13.15Z (approximately 2½ hours after the arrival of the first helicopter) it was reported that only 11 people (all crew members) remained on board the ferry.

At 14.42Z the "on-scene commander" reported the situation under complete control, and he asked the ships in the area to pick up empty liferafts and lifeboats, so they were not searched unnecessarily. At 16.43Z no other survivors were sighted. The 11 crew members on board were asked to leave the ferry if they wanted to be picked up before dark.

At 17.35Z the last man was picked up and at 18.15Z the whole search was cancelled due to darkness. All helicopters landed at airstation Aalborg at 18.46Z after a successful mission in which 69 survivors had been picked up. A further 75 survivors were picked up by 3 different ships in the area.

As it appeared from the helicopters that the wooden lifeboats had most difficulty in the cruel sea, pick-ups were started from these. It was decided to spare the rescue-man and use single lift instead of double lift – which we normally perform – due to the possibility of having the rescue man injured by a collision with the boats, as they were completely unstable in the high sea. A little later the helicopters were requested to evaluate the possibility of picking people up direct from the ferry, but that looked far too risky as the ferry rolled violently $30^0 - 45^0$ and also pitched a great deal.

All swimming survivors were picked up in "double lift", as nearly all of them were completely exhausted from fighting the sea. In such cases the survivors were flown directly to the airfield for quick medical attention.

On one occasion a capsized liferaft which was expected to be empty, suddenly became alive when one of 12 persons on board cut a hole in the bottom of the inverted liferaft with his pocket knife, so that they could get out. They had been standing on the roof of the liferaft, grown ups and children among each other, hardly able to breathe because of the crowding. Some of them jumped into the water and were picked up from there, others were rescued direct from the dinghy.

Blankets and flying jackets were used to protect the most exhausted survivors, and everybody was engaged in helping to preserve his or her self. It was evident that the engagement in helping meant a lot to the instinct of self-preservation.

Even the ship's dog and the ship's money box were picked up.

Fifteen of the pick-ups were made as double lift.

The mental condition of the first crew in the area, as they were alone for the first 1½ hrs, was that they were a bit nervous and afraid of not being able to overcome their task, by not being able to make the pick-ups quickly enough. All survivors were waving their arms and it was almost impossible to decide where to start, as you could not be sure who would be first to give up and drown. The crew hoped they could keep all their equipment working for the whole operation. From the tremor in their voices one could hear that the crew members were working under a high pressure.

None of the crews had had any special education or training in how to stand the stress of seeing severely wounded or sick persons. They are all able to concentrate on pick-ups of 1 or 2 persons, as this only takes a short time, but this was going to be a long-lasting and fatiguing affair. One's insufficiency in this fight with the elements was realized right away. It would be hard not to feel some guilt if the situation worsened and many of the survivors were not picked up in time.

It will always be of great help to have a doctor on board on special missions such as this when serious casualties are expected. That is - he can take the responsibility for the patients when they get on board the helicopter.

The rescue man had to withstand severe stresses while doing his job. He was often dragged through and under the surface of the water and maybe hit by different objects. All this exhausted him so much that after just one double-lift he could hardly stand. The hoist operator who uses his right hand to guide the hoist wire and reduce the oscillations became very tired and tensed-up in all muscles as he also had to help people into the helicopter.

One of the surgeons who took part has sent me a few notes on the state of the survivors.

Most of the patients were severely physically affected by the unpleasant experience. Most of them were exhausted and wet and many were worried about the unknown destiny of other members of their families. All this induced a light stage of shock, which for the most of them was quickly relieved by friendly treatment, warm clothes, warm food and a feeling of security, especially when they got information about their relatives.

All together, 19 patients (10 women, 8 men and 1 boy) were sent to the hospital. Nationalities represented were: Norway, Holland, Italy, France and Germany. Only 5 of these patients were affected by the cold water. One had a small rather insignificant injury of the spine, 5 others had minor abrasions, but were not seriously affected and had no fractures. Two had serious bruises of the ribs, spine and feet, but no fractures. One had a broken arm and 2 showed signs of minor concussion. Three had heart-trouble and a couple had water in their lungs. One showed early pneumonia. Some were very depressed, and one had lost her husband, who was dead on arrival although he had received special treatment all the way from the very minute he got inside the helicopter.

What characterized all the casualties was the influence which the cold water and wet clothes had had on them. The state of fear, which for some came close to a nervous break-down, was marked in all.

Only one needed to be kept at the hospital for longer than a period of 24 hours. All were discharged in good condition, though some required further treatment at their hometown hospitals.

From a medical point of view the whole operation was an easy affair without major problems.

A very impressive thing happened when all the survivors got permission to buy new clothes. This, coupled with good news about their relatives, improved the condition of everybody right away.

Food for thought: A 12 year old boy *sitting* in the sling holding on with only *one* hand, waving and laughing to the whole crew and with a repartee on his lips; 15 minutes later the first pilot looked at him, and told me later that he now knows what the boy's appearance will be when he reaches an age of 50 or 60 because that was what he looked like then.

After 2 to 2½ hours in the cold water – temperature below 10°C – a 24 year old married Danish girl was rescued. Her story in short was that when she jumped overboard wearing a life-vest she had her little dog in her arms. This dog meant as much to her as a baby to other wives. She was dressed in a rather heavy coat and walking shoes. She tried to keep the head of the dog clear of the sea, but some time later she had to admit that the dog had died, and that she had to let it go. Shortly after she had left the ferry she had kicked her shoes off as they felt uncomfortable. Now, as she no longer had the dog to think of, she realized the creeping coldness spreading up through her legs and body. She was floating further and further away from the ferry, but all the time trying to draw attention from either one of the aircraft or one of the ships taking part in the rescue. Once she was very close to a Russian ship, but she passed it on the side on which no look-out was being kept. She screamed for help in Danish and waved her arms. A little later it came to her mind, why did she scream for help in Danish? If they had heard her they would not have understood her anyway. Once she got entangled in bladder-wrack; it got around her neck and body. She remembered that she, as a little girl, had had much fun in "popping" the bladders in the fronds of this type of seaweed. Doing this again kept her active for some time, and drew her thoughts away from her more and more critical situation. Then she discovered the seagulls. At one moment was completely aware that there were gulls flying around her. The next moment she thought that they were vultures and that they were attacking her like the birds in the Hitchcock film "The Birds". All these and many other things which happened to her during her long stay in the cold water might have played a part in her success in staying alive for so long, by keeping her mind occupied with different activities and her thoughts away from her more and more critical situation.

One hitherto unmentioned factor which is probably of the greatest importance in the success of her survival is that up to an age of 20 she had taken part in all sorts of swimming, more or less every day. She had taken part in several contests and was a swimming certificate holder.

A lot of people would probably have given up long before due to panic, the cold water and the hopelessness of the situation. In fact the cold water affected this girl so much, that one arm more or less froze in a fixed waving position over her head and at the moment of rescue she could move nothing but the distal part of her little finger. She cannot remember a thing from the beginning of the rescue until her arrival in hospital, and was probably at the moment of the rescue as close as she could come to unconsciousness. The next month or so, she was broken in body and mind, but after participation in a paper on the "Skagerak" operation where she heard about others' difficulties and about the whole operation, she started recovering.

But she will not for a very long period take a bath in a bathtub, visit a swimming-pool or swimbath, or take a swim from a beach due to the psychic influence of the whole disaster and her long stay in the cold water.

The crews of the helicopters didn't have a healthy and sound sleep the first couple of days due to the many impressions, mostly of frightened people's faces, but also a few cases of human beings' behaviour when they turn into, what you could call a sort of desperation, not to say animals, in their fight for life by being first in being rescued ahead of children and women.

DISCUSSION

Col Malone, thanking Major Petersen for his paper, said that he was sure that he was reflecting the views of the audience in stating that Major Petersen had given a remarkably fine account of the physical and mental effects of exposure and danger. His was a most valuable first-hand account of the type of situation which any rescue organisation must be prepared to deal with.

SUMMARY OF SESSION I

by Col R.S.Malone, USAF, MC

We have reviewed the development of helicopters in military and medical tactics, noting how their increasing versatility by clever design leads to more widespread application. Indeed, it is through this medium that the technological skills of our societies are applied to maintain the freedom of those who struggle to mould their own destiny.

Col Cody has shown the order of battle as helicopters are employed: tactics, mobility, fire power, logistics, command. Wg Cdr Eley has traced the vicissitudes of operations in unmapped, to a degree unknown, areas, where men overcome the limits of their equipment by ingenious techniques. I believe here we were told of the ultimate capabilities of crews in terms of flying hours and fatigue. Then Lt Cdr Williams summarised the final produce of a rapidly moving evolutionary process – the creation of a task force which is uniquely mobile and yet carries its own logistic support.

At this point we examined the special applications of the helicopter in rescue operations. Capt.Buckley indicated the use of rescue personnel who were trained as medics, parachutists and in the use of SCUBA. Air refuelling was shown to be feasible. Gen.Paganelli demonstrated the practicability of helicopter operations in civil disaster casualty control. He confirmed the problems of air hoist, at the same time re-emphasising the psychological boost which orbiting rescue personnel provide the stricken. Major Petersen described a huge operation conducted in a short time under difficult conditions. He delineated psychological problems presented by casualties.

Vulnerability of man has really been the underlying theme of all these presentations. It has been shown repeatedly that there must be a welding of man with machine – that meticulous training of flight crews and commanders is, as usual, the essential ingredient to assure success. Man's frailties are both emotional and physical. He fumbles when afraid – but his fear can be eradicated with training. Under operational circumstances, only strict discipline with regard to field sanitation can control diseases. An enteric upset, particularly a diarrhoeal disease, can abort a mission just as surely as gunfire or fuel lack. While he may spend much time in the air, man's natural environment is still the earth where he lives in ecological balance with bacteria.

LES CONVENTIONS DE GENEVE ET LA PROTECTION JURIDIQUE DES TRANSPORTS SANITAIRES PAR HELICOPTERE DANS LES CONFLITS ARMES

par

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SUMMARY

The juridicial protection of helicopters on aeromedical missions comes under articles 36 and 37 of the First Geneva Convention dated 12th August 1949, and article 39 of the Second Convention.

The present juridicial status is ineffectual and inoperative due to gaps, ambiguities and defects. These are:

(1) Lack of precision in the definition of protected aircraft.

(2) Insufficient means of signalling and identification of helicopters on an aeromedical mission.

(3) The obligation of a preliminary agreement on flight routes between parties at war.

(4) Lack of precision in the practical delimination of the areas which can be flown over, especially in forward missions.

To fill these gaps and remedy these lacks of accuracy, the author suggests:

(1) that protected helicopters include not only sanitary helicopters proper, but also helicopters on occasional or temporary medical missions;

(2) that these two categories of helicopters be signalled, in addition to the traditional and distinctive red cross sign, by a direct visual system of lights;

(3) that the obligation of any preliminary agreement on the flight route between parties at war be removed for medical missions;

(4) that it should be prohibited to fly over enemy territory, the territory occupied by the enemy and the contact areas of combat units. Provisions should be laid down to specify the fate of an aircraft having landed, by accident or necessity, in a forbidden area or a neutral zone.

The author will present the text which was written out in June 1966, in conformity with these principles, by the medico-legal Committee of Monaco, at the request of the International Red Cross Committee, with a view to modifying the texts concerned with medical aviation in the First and Second Geneva Conventions of 12th August 1949.

LES CONVENTIONS DE GENEVE ET LA PROTECTION JURIDIQUE DES TRANSPORTS SANITAIRES PAR HELICOPTERE DANS LES CONFLITS ARMES

Général Major Médecin E. Evrard

1. GENERALITES

Les voeux émis par diverses sociétés ou commissions juridiques (50e Conférence de l'International Law Association, Commission de Droit International Médical de I.L.A. dans sa réunion de janvier 1962 à Liège, Société française de Droit International Médical dans sa séance du 14 juin 1962) ont attiré l'attention sur le problème, important pour le fonctionnement du Service de Santé en temps de guerre, de la protection de l'hélicoptère sanitaire. Ils complètent les cris d'alarme lancés par des médecins et des juristes. Citons notamment des Cilleuls (Revue Internationale des Services de Santé, août-septembre 1962, p.407-410), Monnier (Revue du Corps de Santé Militaire, 1957, p.392-401), Petchot-Bacqué (Le Médecin de Réserve, mars-avril 1960, p.43-49), de La Pradelle P. (Bulletin International des Services de Santé, août 1954, p.376-380), Schickelé A. (Revue Générale de l'Ai . 1950, No.4, p.847-854), de Lasala Samper (La proteccion a los heridos, enfermos y naufragos de las fuerzas armadas en campaña – 1964) etc.

La Société Internationale de Droit pénal militaire et de Droit de la guerre a mis cette question à l'ordre du jour de ses travaux en 1964. Elle a chargé son groupe de travail pour la protection de la vie humaine dans la guerre moderne d'en faire une étude approfondie.

La Commission médico-juridique de Monaco a consacré à ce problème une partie importante de sa 5e Session en juin 1966.

L'hélicoptère est un *aéronef*, puisqu'il s'agit d'un véhicule se déplaçant au dessus du sol. Lorsqu'il accomplit une mission sanitaire, sa protection relève des articles 36 et 37 de la Première Convention de Genève du 12 août 1949 et de l'article 39 de la Deuxième Convention. Ces textes constituent actuellement le statut juridique protecteur de l'*aviation sanitaire* dans le droit international.

L'aviation sanitaire a été introduite dans la Convention de Genève lors de sa revision de 1929. Un statut protecteur particulier lui fut accordé. A cette époque, le terme 'aéronefs sanitaires' dont il est fait usage dans le texte de la Convention ne s'adressait en pratique qu'aux avions. L'hélicoptère n'était pas encore né.

Les conflits armés qui surgirent après 1929 mirent tous en évidence les difficultés insurmontables de la mise en application des dispositions particulières du texte de la Convention de 1929.

Durant la deuxième guerre mondiale, notamment, tous les belligérants rompirent avec les principes du transport des blessés sous le couvert de la Convention de Genève.

A défaut de possibilités de fonctionnement et de rendement d'une aviation sanitaire, répondant en vue de sa protection, aux clauses de la Convention de Genève, l'aviation militaire de transport se vit confier l'évacuation des blessés par voie aérienne. Cette évacuation devint ainsi une mission militaire absolument normale.

L'évacuation massive des blessés et malades par air est certainement l'une des réalisations les plus importantes de la Deuxième guerre mondiale dans le domaine médico-militaire. Sans doute, présents à bord d'avions de transport militaires, aménagés temporairement en avions sanitaires et effectuant leurs vols sans tenir compte des exigences de la Convention, le personnel sanitaire et les blessés ne pouvaient prétendre, au cours du transport, à une garantie quelconque de protection. Force était donc d'accepter le risque que comporte l'emploi en temps de guerre d'un avion militaire de transport ne répondant pas aux conditions d'immunité. Mais les évènements ont prouvé que le risque était minime, à condition que le belligérant possédât la supériorité de l'air dans la zone où s'effectuait le transport et durant la période de son accomplissement et à condition de ne pas survoler des zones défendues par la DCA ennemie.

Au contraire, les risques deviennent énormes en cas de méconnaissance de ces conditions qui sont indispensables pour la mise en jeu des moyens de transport aériens avec le souci d'un degré suffisant de la sécurité du vol.

Lorsque s'ouvrit en 1949 la Conférence chargée de préparer la revision de la Convention de Genève, la formule de l'aviation sanitaire telle qu'elle figurait dans la Convention de 1929 apparaissait, à la lumière des événements de la Deuxième guerre mondiale, sans grande portée pratique.

Néanmoins, les mêmes principes furent repris dans les Conventions du 12 août 1949. Il est vrai que quelques dispositions nouvelles tentèrent d'apporter un peu de souplesse. Les aéronefs ne doivent plus nécessairement être peints en blanc, mais ils doivent porter la croix rouge sur fond blanc sur leurs faces inférieure, supérieure et latérales; ils sont autorisés à survoler les pays neutres sous certaines conditions. Mais, par contre, pour pouvoir bénéficier de la protection, non seulement l'interdiction de survol du territoire ennemi ou occupé par l'ennemi, déjà prévue au texte de 1929 est renforcée et précisée, mais, changement capital, les aéronefs sanitaires ne seront respectés que 'pendant les vols qu'ils effectueront à des altitudes, à des heures et suivent des itinéraires spécifiquement convenus entre tous les belligérants intéressés'.

Cette clause, pour reprendre l'expression d'un juriste éminent qui est un des pionniers du statut international de l'aviation sanitaire (Paul de La Pradelle), 'cloue l'aviation sanitaire au sol'.

La guerre de Corée ne fit que confirmer d'une manière éclatante, le rôle irremplaçable et la valeur considérable de l'avion militaire de transport pour l'évacuation rapide des blessés vers les hôpitaux de traitement définitif dans les zones de l'arrière et de l'intérieur, c'est-à-dire à des milliers de kilomètres des zones d'opérations. L'on n'assista à aucune tentative de protection juridique de ces transports aériens. Ceux-ci, de même que pendant la Deuxième guerre mondiale, furent intégrés dans les plans et les

principes de la logistique aérienne, et, dans les conditions de ce conflit très localisé, furent menés à bonne fin sans qu'on ressentit le besoin d'un status international de protection.

Mais en même temps, la guerre, de Corée marqua l'apparition de l'hélicoptère comme 'ambulance du ciel', et cela, même dans la zone des combats. Véhicule sanitaire particulièrement commode et efficace, il manifesta des brillantes qualités pour le ramassage du blessé sur le terrain et son évacuation primaire.

La faible altitude d'emploi de cette machine, sa vitesse relativement peu élevée, son utilisation sur le terrain même du combat sont autant de caractéristiques qui l'exposent à des risques d'attaques par les armes d'infanterie et d'artillerie au cours de sa mission sanitaire. Il n'est donc pas étonnant que ce soit à propos de l'emploi de l'hélicoptère en temps de guerre que des voix autorisées se soient fait récemment entendre pour déplorer les graves lacunes qui subsistent dans le status international juridique de l'hélicoptère sanitaire.

En 1954, le juriste français Paul de La Pradelle, déjà cité plus haut, déclarait:

'Qu'on le veuille ou non, dans leur état actuel, les Conventions de Genève condamnent l'emploi de l'hélicoptère en temps de guerre. L'article 36 est inapplicable au cas de l'hélicoptère.' (Bulletin International des Services de Santé, août 1954, p. 376-380.)

Dans des publications récentes, médecins et juristes ont continué de demander une solution à cette situation préoccupante. Le bien-fondé de leur argumentation repose sur des faits: Les guerres d'Algérie et du Vietnam ont montré que les conceptions qui avaient été bâties au cours de la guerre de Corée sur l'emploi normal de l'helicoptère pour des missions sanitaires dans la zone des combats étaient en fait très optimistes: les pertes importantes en hélicoptères, abattus au cours de ce genre de missions, par le tir d'armes légères en provenance d'éléments avancés ennemis et de petits groupes isolés et camouflés en témoignent.

Dans un rapport préparé pour la 50e Conférence de l'International Law Association (juin 1962), le Médecin Général R. Jovanovic (Yougoslavie) écrit:

'Les hélicoptères, d'après les règles qui sont en vigueur, ne sont pas suffisamment juridiquement protégés, étant donné qu'ils ne peuvent pas s'adapter aux conditions prévues pour les avions sanitaires et ce sont précisément ces conditions qui constituent la base de la protection juridique.'

Il faut souligner que des progrès techniques considérables ont encore permis d'élargir et de diversifier la gamme des emplois militaires de l'hélicoptère. Outre les missions d'observation, de renseignements, de photographie, de transport de troupes, l'hélicoptère peut aussi accomplir de véritables missions de combat: des types d'hélicoptère sont actuellement qualifiés d'hélicoptères d'assaut.

Vouloir réserver l'hélicoptère uniquement à des missions sanitaires, comme certains médecins et juristes l'ont proposé avec une certaine candeur, pour sortir des impasses actuelles, est une pure vue de l'esprit, doublée de naïvité. C'est méconnaître la réalité et s'enfoncer davantage dans le royaume des illusions.

Les études, voeux et travaux, qui se sont surtout concentrés sur le problème de la protection juridique de l'hélicoptère, pourraient donner à penser que les médecins et juristes, spécialistes du droit international médical, découragés par les complications de l'élaboration d'un statut protecteur de l'aviation sanitaire englobant tous les aéronefs ou conscients de la profonde désaffection montrée jusqu'à présent par les milieux militaires pour l'immunisation des avions en mission sanitaire, préféreraient trouver une solution limitée à l'hélicoptère, qui, lui, est particulièrement exposé dans ses missions de ramassage à l'avant et d'évacuation primaire.

Une telle conception, tendant à donner un status particulier à l'hélicoptère, serait peu heureuse.

En outre, techniquement, elle ne se justifie pas.

1. Elle serait peu heureuse parce qu'elle retarderait encore la réglementation du statut de l'aviation sanitaire. Il ne nous paraît donc pas opportun de délaisser le concept général de l'aéronef, pour s'engager dans les particularités techniques actuelles d'un type d'appareil, sous prétexte que sa voilure est tournante et qu'il peut faire du 'sur-place'.

2. Cette conception de différenciation ne se justifie pas. En effet, l'inévitable réadaptation du statut de l'aviation sanitaire aux conditions actuellement prévues pour la conduite de la guerre porte sur quatre points essentiels. Ce sont précisément ceux dont les textes, dans les Conventions I et II, contiennent des lacunes, des équivoques et des imperfections. Ils se rapportent non seulement à l'*hélicoptère*, mais à tous les *types d'aéronefs*, quels qu'ils soient. Ce sont:

(a) *la définition des appareils protégés:* avions et hélicoptères

(b) *l'identification de la mission sanitaire par des moyens complémentaires modernes, visuels ou non visuels.* Ces moyens existent et pourraient être appliqués à tous les aéronefs, dont l'hélicoptère. Certains sont simples et ne sont ni encombrants ni pondéreux. L'adoption de l'un ou de deux d'entre eux répond à un réel besoin pour la protection de tous les types d'aéronefs.

(c) *la suppression des exigences d'accord préalable portant sur l'altitude de vol, l'heure, etc.,* exigences qui dépouillent l'article 36 de la Première Convention de toute valeur pratique pour tous les types d'aéronefs sanitaires. Si l'identification devient aisée et claire pour tous les combattants des armées de terre, air et mer dans les deux camps, cette clause, mortelle pour l'emploi de l'aviation sanitaire, peut être abolie, parce qu'elle est dépourvue de sa justification.

(d) *la délimitation pratique de la protection juridique des aéronefs en mission sanitaire au-dessus des différentes zones des terrains d'opérations.* Cette délimitation doit être précisée pour tous les types d'aéronefs. L'hélicoptère ne constitue pas une exception, bien que les médecins militaires et les juristes en droit international aient, semble-t-il, polarisé actuellement leur intérêt sur ce cas particulier d'appareil parce que le problème de la protection juridique de l'hélicoptère en mission sanitaire se pose avec une acuité pressante, dans la zone des combats, pour des missions de ramassage sur le terrain et d'évacuation vers des formations de triage et de traitement chirurgical d'urgence.

Dans ces quatre différents secteurs, c'est uniquement aux problèmes de l'*hélicoptère* que nous bornerons cette étude.

Après avoir mis en évidence la nature de ces lacunes et équivoques qu'il importe de faire disparaître, nous proposerons une formule de solution, en veillant non seulement à ce qu'elle soit valable pour assurer la protection juridique de l'hélicoptère sanitaire mais aussi à ce qu'elle puisse s'intégrer à l'occasion d'une révision des Conventions de Genève dans des textes capables d'assurer l'immunisation, sous certaines conditions bien précises, de *tout type d'aéronefs sanitaires.*

2. LACUNES, EQUIVOQUES ET IMPERFECTIONS DU STATUT JURIDIQUE ACTUEL

2.1 Définition des Appareils Protégés

Selon le 1er alinea de l'article 36 de la Convention I, la bénéfice de la protection est accordé aux 'aéronefs exclusivement utilisés pour l'évacuation des blessés et des malades ainsi que pour le transport du personnel et de matériel sanitaire'.

Cette formule est équivoque, car elle peut désigner soit les *aéronefs sanitaires*, au sens restreint du terme, c'est-à-dire les appareils affectés en permanence et en exclusivité aux services de santé des armées, soit les *aéronefs militaires opérationnels*, qui seraient *occasionnellement* affectés à une mission sanitaire temporaire, alors qu'ils sont normalement utilisés à des fins d'hostilités (transport de troupes ou de matériel).

Cet alinea de l'article 36 a donné lieu à des commentaires divergents qui ont encore accentué l'équivoque. Cette dernière porte tout autant sur les avions que sur les hélicoptères.

Nous limitant à ceux-ci, nous devons constater la disproportion entre les disponibilités en appareils et la variété croissante des missions que les Etats-Majors peuvent leur confier dans la conduite d'une guerre moderne. Cette disproportion ne favorise pas actuellement une tendance à leur dispersion ni à leur spécialisation exclusive au profit d'un service, notamment le Service de Santé.

Certes, outre l'emploi d'hélicoptères banalisés à des fins occasionnellement sanitaires, les Américains affectent des hélicoptères à leurs unités médicales. Ils prévoient des compagnies médicales aéro-sanitaires pourvues d'hélicoptères dont les pilotes appartiennent au Medical Service Corps.

Toutefois, le nombre de ces hélicoptères spécifiquement et exclusivement sanitaires ne représente qu'un faible pourcentage du parc d'hélicoptères américains.

Par contre, en France et en Angleterre, pour ne citer que deux nations disposant également d'un nombre important d'hélicoptères, il n'est pas actuellement prévu d'unités d'hélicoptères militaires, exclusivement réservés au transport sanitaire. C'est également le cas en Belgique. Chaque pays a, dans ce domaine, sa conception particulière.

Il est à présumer que la plupart des Services de Santé militaires, mêmes s'ils possèdent en propre des hélicoptères sanitaires, devront surtout compter en temps de guerre, pour couvrir tous leurs besoins en matière d'évacuation, sur des appareils à usages multiples, convertibles en version sanitaire à la demande.

Certes, tous les Services de Santé militaires, conscients des missions qui les attendent en temps de guerre, se rendent compte qu'ils devraient disposer d'un parc bien étoffé d'hélicoptères sanitaires, répondant aux exigences des Conventions. A défaut de pouvoir atteindre cet objectif idéal, il importe que du moins les appareils mis à leur disposition, sous quelque modalité que ce soit (mise aux ordres, affectation pour une certaine durée à une unité médicale, etc.) portent alors ostensiblement les signes d'identification prévus pour les appareils sanitaires, et actuellement la croix rouge, en attendant mieux, malgré les insuffisances du système.

Ceci est particulièrement important pour les hélicoptères légers affectés aux unités médicales pour des missions de ramassage et d'évacuation primaire, dans la zone de l'avant.

En toute logique, les Commentaires de la Convention No. I de 1949, publiés sous la direction de Mr Pictet[5], attribuent à un aéronef temporairement utilisé pour une mission secourable le bénéfice de la protection s'il respecte les clauses de l'article 36. Il est évident qu'en temps de guerre on n'aurait que rarement le temps de peindre, d'effacer et repeindre des croix rouges sur fond blanc, selon la nature des diverses missions se succédant au cours d'une même journée ou d'une même phase d'opérations militaires.

Il est heureux que la plupart des types d'hélicoptères permettent une fixation aisée et très rapide de panneaux amovibles portant des croix rouges sur fond blanc. On peut regretter que ce système ne puisse pas encore être généralisé sur tous les types d'hélicoptères. La vitesse de déplacement, moins grande que celle des avions, permet d'éviter l'arrachement de ces panneaux pendant le vol. Etant donné l'absence d'empennage chez les hélicoptères, il n'y a pas lieu de redouter, comme c'est le cas pour les avions, que ces panneaux viennent bloquer ou détériorer des parties vitales de l'appareil, s'ils viennent à se détacher en vol sous l'influence du déplacement d'air.

Pour la plupart des hélicoptères, c'est à dire ceux qui sont demeurés banalisés et peuvent être convertis momentanément en version sanitaire, on se trouve donc devant une situation beaucoup plus favorable sur le plan pratique que pour l'avion en ce qui concerne les exigences actuelles de l'article 36, en cas d'alternance rapide des missions sanitaires et des missions purement militaires, du moins pour ce qui regarde le signe d'identification de la croix rouge.

La première question qui doit être posée et résolue sans ambiguité dans les textes est donc de savoir si cette pratique, basée sur l'expérience extrêmement favorable des récents conflits doit être confirmée en réservant le bénéfice de la définition de la Convention aux hélicoptères banalisés, effectuant *occasionnellement* une mission sanitaire.

Il est bien évident qu'un statut futur de l'aviation sanitaire ne peut condamner une telle pratique ni y demeurer indifférent. Il doit au contraire la favoriser et garantir l'immunité de la mission sanitaire effectuée dans de telles conditions.

Mais ceci ne doit nullement exclure la recherche parallèle de la constitution d'un parc d'hélicoptères sanitaires au sens fort du terme, dans les Nations qui n'en possèdent pas ni son expansion dans les Etats qui en disposent déjà.

Bien que l'expérience des récents conflits n'ait guère été favorable au concept d'un parc d'hélicoptères sanitaires exclusifs, les juristes promoteurs de ce concept en défendent l'idée sous une variante qui permettrait l'institution en permanence, pour le temps des hostilités, d'une flotte aérienne sanitaire, placée sous la dépendance des services de santé des belligérants et qui, en aucun cas, ne pourrait être utilisée pour des opérations de guerre. Il s'agirait de mettre à la disposition des belligérants, à la condition, sans doute, qu'ils ne soient jamais banalisés à des fins militaires, des moyens aériens (avions et hélicoptères) publics et privés, que les Etats neutres et les Institutions internationales, placés par nature ou par fondation au dessus de la mêlée, seraient susceptibles de mettre à la disposition des belligérants. Ces appareils feraient l'objet d'une immatriculation spéciale. L'avenir dira si une telle conception est matériellement réalisable. Malgré les difficultés pratiques qu'elle comporte, elle est, en tout cas, juridiquement défendable. Elle avait déjà fait l'objet d'une proposition de la Principauté de Monaco et de la Finlande lors de la Conférence diplomatique de Genève de 1949, proposition qui fut alors repoussée, probablement en raison de son caractère de nouveauté.

Notre conclusion sur cette analyse de la situation, en ce qui concerne les appareils relevant de la définition de l'article 36 sera nette. Le futur statut protecteur de l'hélicoptère sanitaire doit lever toute équivoque en prenant en considération sans ambiguité deux catégories d'appareils:

(a) les hélicoptères militaires banalisés, accomplissant des missions sanitaires occasionnelles, à condition qu'ils se signalent pendant ces missions sanitaires par des moyens d'identification internationalement prévus à cet effet. Cette catégorie doit actuellement recevoir un rang prioritaire, puisque ces appareils sont les plus nombreux.

(b) les hélicoptères sanitaires, spécialement et exclusivement réservés à des fins sanitaires.

Cette solution polyvalente supprime toute équivoque et tient compte de la démesure qui existera toujours, sur un theatre d'opérations militaires actives, entre le nombre d'hélicoptères disponibles pour le service de santé et le nombre de victimes dont la vie dépend d'une prompte évacuation vers une formation de traitement.

2.2 Signalisation et Identification des Hélicoptères en Mission Sanitaire

Il est clair que ce sont les blessés qui doivent être protégés . Les moyens de transport ne doivent pas être protégés pour eux-mêmes, mais, parce qu'ils transportent des blessés ou du matériel sanitaire. Il importe donc de pouvoir identifier clairement et sans discussion l'aéronef effectuant une mission de transport sanitaire.

La Convention a cru résoudre ce problème essentiel de l'identification par l'imposition de l'emblème de la croix rouge sur un fond de peinture blanche placé sur les faces inférieure, supérieure et latérales de l'appareil. (Article 36 de la Première Convention, alinea 2.)

Le signe traditionnel de la croix rouge et les signes concurrents admis (croissant rouge, lion et soleil rouges) conserveront toujours pour leurs usagers et pour les tiers qui ont accepté de les respecter, une valeur morale élevée de symbole d'immunité. On ne peut donc objecter valablement à leur emploi.

Ce moyen d'identification est-il efficace dans le cas des aéronefs? Actuellement, il ne l'est certainement plus, pour autant qu'il l'ait jamais été.

D'abord, il va de soi que ce moyen n'a aucun sens pour le vol de nuit.

Dans le vol de jour, il n'est pas toujours possible de distinguer facilement la couleur blanche et la croix rouge. C'est notamment le cas sous l'effet des reflets du soleil et par temps brumeux.

L'hélicoptère vole pratiquement toujours en-dessous de 350 mètres. L'altitude en opérations sera le plus souvent voisine de 15 à 20 mètres sur des itinéraires, ou des cheminements camouflés au maximum aux vues ennemies. Sa vitesse de translation est de loin inférieure à celle de l'avion.

Il semblerait que l'identification par le signe distinctif de la Convention (croix rouge sur fond blanc) soit plus aisée que pour l'avion. Il n'en est rien. Remarquons d'abord que les surfaces disponibles pour le signe de la croix rouge sont souvent moins vastes ou moins visibles que celles des avions, puisque l'hélicoptère n'a pas d'aile et qu'une partie de son habitacle comprend souvent une importante surface vitrée. Les difficultés de détection, puis d'identification sont sujettes aux mêmes aléas que ceux de l'avion, que l'observateur se trouve au sol, en l'air ou à la surface de la mer.

Par temps couvert, ou brumeux, ou aux approches du crépuscule, l'identification sera très difficile, sinon impossible. L'hélicoptère sera toujours une cible qui se profile sur l'horizon, qu'on entend de très loin, qu'on ne peut totalement camoufler et dont l'identification n'est possible que de très près, si on se réfère aux seuls signes peints ou placés sur sa surface.

Les missions sanitaires de l'hélicoptère se déroulent dans des conditions de vol extrêmement différentes de celles où évoluent les avions chargés de semblables missions.

S'il semble exact qu'en pays montagneux ou de relief accidenté, ils peuvent échapper assez facilement aux attaques aériennes quand ils parviennent à éviter l'attaque-surprise, leur faible altitude d'opérations les rend beaucoup plus aisément vulnérables aux tirs d'armes légères en provenance du sol.

Le survol des zones de combat risque de les placer dans des situations extrêmement dangereuses si le caractère de cette mission n'est pas clairement et nettement signalé aux troupes des deux camps, dès que l'hélicoptère est visible, c'est-à-dire longtemps avant que l'on puisse discerner s'il porte des croix rouges sur fond blanc. Enfin, l'hélicoptère, aux approches des éléments avancés ennemis, ou des groupes de guerrilla, risque de devenir, même lorsqu'il est encore au-dessus du territoire ami, une excellente cible.

En ce qui concerne l'identification par des patrouilles aériennes, il faut noter que c'est en raison des défauts de la couleur blanche que l'on a récemment adopté la couleur jaune-orange fluorescente pour les avions et hélicoptères des services de secours et repêchage, pour les avions d'école et aussi pour les avions de transport, affectés au transport des personnages importants.

Au surplus, l'attaque des chasseurs d'interception ne se fait plus à courte distance. L'appareil, de quelque nature qu'il soit, est détecté par le radar, puis identifié comme ami ou ennemi. Même, s'il est reconnu à vue directe, le chasseur passe à l'attaque à la limite de portée de ses armes, bien avant qu'il soit possible de reconnaître la croix rouge ou la peinture blanche.

La portée des moyens de détection par radar et des armes d'interdiction que sont les missiles sol-air et air-air rend caduque et désuète cette notion d'identification par le signe de la croix rouge.

Certes, la deuxième phrase de l'alinéa 2 de l'article 36 (Première Convention) prévoit que les aéronefs sanitaires 'seront dotés de toute autre signalisation ou moyen de reconnaissance fixés par accord entre les belligérants, soit au début, soit au cours des hostilités'. Mais, alors, c'est beaucoup trop tard. C'est en temps de paix qu'il faut pouvoir arriver à cet accord général. Les évacuations sanitaires par air auront lieu dès le premier jour d'une guerre, surtout celles par hélicoptères.

Devant le caractère illusoire et utopique d'une identification uniquement basée sur la croix rouge peinte sur fond blanc, il importe de déterminer ces autres moyens de signalisation ou d'identification susceptibles d'être proposés à l'occasion d'une révision de la Convention.

Dans une étude (Ref. 1) qui a été publiée en 1965, nous avons tenté d'établir quels seraient les moyens visuels et non visuels modernes qui permettraient une identification indiscutable et rapide d'une mission aérienne sanitaire par tous les combattants des trois Forces, sans exiger des appareils inhabituels ou complexes. Et comme la détection précède toujours l'identification, nous n'avons retenu que ceux pour lesquels l'intervalle chronologique entre la détection et l'identification est réduit au minimum.

Pour l'avion, la revue et l'étude des différents moyens existants nous a permis de retenir un moyen visuel *indirect*: un radar secondaire du type IFF - SIF, choisi, par l'intermédiaire de l'OACI, dans un des modes utilisés. En principe ce serait le mode 3A, commun aux civils et aux militaires. Ce moyen permettrait aux postes de controle aérien opérant pour la chasse d'interception et aux bases de missiles, d'identifier intantanement, à très longue distance, l'appareil en mission sanitaire. Ce système, dont l'efficacité ne peut être attendue qu'à une altitude supérieure à 1.000 metres, ne conviendrait évidement pas aux hélicoptères.

Heureusement pour ceuxci, un moyen visuel direct suffit, en raison de ses déplacements à basse altitude: la signialisation par feux colorés tournants ou clignotants. Rien n'empêche d'ailleurs d'adopter aussi ce moyen pour tous les aéronefs quel que soit leur type.

La distance permettant l'identification grâce à la couleur de l'appareil ou à des signes de couleur sur la surface de l'appareil (bandes colorées, croix rouge, etc.) est de l'ordre du kilomètre. Elle peut être supérieure s'il s'agit de jaune-orange fluorescent.

L'identification basée sur la silhouette de l'aéronef, la peinture de la totalité ou d'une partie de la surface et sur la présence de la croix rouge sur fond blanc est insuffisante de jour et impossible de nuit.

L'émission de signaux lumineux augmente d'au moins trois fois, de jour comme de nuit, la distance de détection et d'identification d'un aéronef par rapport à la distance basée sur la silhouette et la couleur, les conditions atmosphériques étant semblables. Il serait donc désirable d'utiliser ce genre de moyen. Pour le vol de jour, c'est la lumière rouge qui se voit le plus aisément sur un fond gris-bleu de ciel ou dans la brume atmosphérique. La détection, de nuit, d'une lumière rouge est également excellente. De nuit, la détection des avions, rien que par les lumières de navigation, actuellement utilisées, est déjà possible à 700 mètres par ciel couvert, à 1.400 mètres par ciel clair, à 2.000 mètres s'il y a quartier de lune, à 3.000 mètres par pleine lune, mais on annonce la prochaine application de systèmes ayant une portée beaucoup plus grande. La détection et l'identification sont bien plus aisées quand on utilise une succession de flashes plutôt qu'une lumière continue. Comme les couleurs actuellement utilisées pour les feux de navigation sont le rouge, le blanc et le vert, il est probable que c'est à une autre couleur qu'on devrait avoir recours pour le feu tournant d'identification de la mission sanitaire. Au surplus, les avions de transport possèdent déjà un feu tournant d'identification rouge, visible jusqu'à 10 kilomètres. Il en résulte que l'adoption d'un moyen d'identification par feu coloré exigerait l'accord préalable de l'Organisation de l'Aviation Civile Internationale (OACI) mais ce feu devrait aussi avoir des caractéristiques telles qu'il ne puisse prêter ni à confusion ni à abus.

Il appartiendrait donc à la Convention de déterminer ces caractéristiques comme, par exemple, la fréquence des flashes par minute et leur durée. Rien n'empêche d'utiliser un système de code par flashes courts et longs, pour autant qu'il favorise l'identification par tous les combattants.

L'intensité de cette lumière devrait être fixée également. Il est certain qu'un minimum, à déterminer par les experts, doit être imposé.

Afin de ne pas gêner les qualités aérodynamiques de l'avion ou de l'hélicoptère et d'éviter les sources de confusion, il y aurait lieu de fixer l'emplacement ou les emplacements de ces lumières. Il semble qu'une localisation sous le nez de l'avion et à la face inférieure de l'hélicoptère constituerait un emplacement de choix. Des experts se mettraient aisément d'accord sur ces points de détail.

Un tel système lumineux pourrait être installé à demeure sans difficulté sur tous les hélicoptères, et même sur tous les avions de transport. Il fonctionnerait sur l'alimentation électrique de l'aéronef. Lorsque la mission présente un caractère sanitaire, il suffirait au pilote d'enclencher le fonctionnement automatique jusqu'à la fin de la mission sanitaire.

Dans la spécification relative à ce signal lumineux d'identification de la mission sanitaire, nous proposons les caractéristiques ci-après:

Couleur: rouge

Nature: feux intermittents sous forme de flashes

Fréquence du clignotement: 60 éclats par minute

durée d'un éclat: 0,5 seconde

pause d'un éclat: 0,5 seconde

Puissance: 500 watts minimum

Emplacement: (a) *avion:* à l'avant du fuselage un peu en dessous du nez de l'appareil

(b) *hélicoptère:* à l'avant du fuselage, face inférieure

Pour les deux types d'aéronefs, le faisceau lumineux est dirigé en bas dans le sens normal de translation de l'appareil et forme avec l'axe longitudinal de l'aéronef un angle de 75 degrés.

On objectera peut-être que ce système d'identification, sans ignorer la croix rouge sur fond blanc, s'y substitue dans une certaine mesure. La réponse est aisée. En effet ce ne serait pas la première fois que l'on apporte des variantes au signe distinctif destiné à assurer la protection des Conventions. N'a-t-on pas accordé une valeur officielle à d'autres signes? N'a-t-on pas admis le croissant rouge ou le lion et soleil rouges, pour respecter certaines susceptibilités d'ordre réligieux, alors que le signe de la croix rouge, comme tout le monde le sait, est l'emblème helvétique avec inversion des couleurs, et que ce signe a été choisi en hommage à la Suisse, patrie de Dunant et sans lui attacher la moindre signification religieuse? Puisque ce précédent existe et est consacré par les Conventions, pourquoi n'admettrait-on pas universellement, *en complément du signe traditionnel*, un signe de plus, un code lumineux, simple, efficace, réservé aux moyens aériens? Au reste, les voitures d'ambulance des services civils de secours de plusieurs pays et même des services de santé militaires n'utilisent elles pas déjà des feux lumineux pour faciliter leur passage dans les rues encombrées et franchir des carrefours sans devoir respecter les règles de la circulation?

Si un moyen lumineux de ce genre était admis et universellement reconnu, il aurait l'avantage de pouvoir bénéficier des nombreux progrès que les recherches sur les méthodes d'illumination pour la photographie de jour et de nuit permettent d'entrevoir et d'espérer.

Ainsi donc, on dispose actuellement de dispositifs lumineux, simples et puissants, valables de jour, de nuit et par tous les temps. Leur portée n'étant limitée que par la ligne du regard pour le combattant terrestre, ils permettent la simultanéité de la détection et de l'identification.

2.3 Suppression de l'Accord Préalable sur le Plan de Vol

L'article 36 de la Convention No. 1 de 1949 prévoit que les aéronefs sanitaires ne seront respectés que 'pendant les vols qu'ils effectueront à des altitudes, à des heures et suivant des itinéraires spécifiquement convenus entre tous les belligérants intéressés'.

Une limitation aussi sévère de l'emploi des appareils fut introduite en 1949, sous prétexte d'assurer la sécurité des vols, l'identification ne reposant que sur le signe de la croix rouge étant jugée illusoire.

Le texte de l'article 36 de la Convention No. 1 de 1949 ne précise cependant pas l'échelon auquel on devra recourir.

Dans la guerre moderne, atomique ou conventionnelle, l'évacuation des pertes par voie aérienne est chose essentielle. Il en est de même dans les opérations du type guerilla.

Le fonctionnement du Service de Santé n'est plus concevable sans elle. Aussi, il est clair que les besoins d'une évacuation sanitaire dans un conflit armé important, et, a fortiori, dans une guerre totale, ne pourront jamais attendre que puisse se réaliser une convention préalable entre belligérants, convention combien problématique.

Il est permis d'ailleurs de se demander quelle est l'utilité pratique d'une Convention qui prévoit l'établissement d'une autre Convention, plus limitée certes, mais à établir dans les conditions difficiles d'un conflit, pour pouvoir sortir ses effets.

Les exigences de cette nature, à elles seules, font perdre à l'article 36, toute valeur pratique. Ces difficultés, qui tuent toute possibilité d'une organisation rationnelle des transports aériens sanitaires, juridiquement protégés, sont particulièrement graves en ce qui concerne l'emploi des hélicoptères à des fins sanitaires. Dans la zone de l'avant, c'est pratiquement pour la relève et le transport de cas graves, non soignés ou sommairement soignés, que l'on songera à appeler l'hélicoptère. On ne voit pas comment, dans ces conditions d'urgence, l'on pourrait prévoir les heures, altitudes, itinéraires, cheminements, plans de vol dans le cadre d'un accord préalable entre les belligérants intéressés comme le demande l'article 36 (Première Convention).

Cette clause doit donc être radicalement supprimée. C'est elle qui 'cloue au sol' l'aviation sanitaire telle qu'elle est prévue dans le statut juridique actuel.

Si l'identification devient aisée et claire pour tous les combattants des armées de terre, air et mer dans les deux camps, cette clause, mortelle pour l'emploi de l'aviation sanitaire et plus particulièrement pour l'emploi de l'hélicoptère en mission sanitaire, en temps de conflit armé, doit être abolie, puisqu'elle est dépourvue de signification.

2.4 Délimitation Pratique de la Protection Juridique des Hélicoptères en Mission Sanitaire au Dessus des Différentes Zones des Theatres D'Opérations

Cette délimitation doit être précisée pour *tous les types* d'aéronefs. L'hélicoptère ne constitue pas une exception, bien que les médecins militaires et les juristes en droit international aient, semble-t-il, polarisé actuellement leur intérêt sur ce cas particulier d'appareil parce que le problème de la protection juridique de l'hélicoptère en mission sanitaire se pose avec une acuité pressante, dans la zone des combats, pour des missions de ramassage sur le terrain et l'évacuation vers des formations de triage et de traitement chirurgical d'urgence. Pour placer le problème sur des bases réalistes, il faut tenir compte de deux facteurs:

1. Les hélicoptères militaires non armés, tant lourds que légers, seront employés au profit du Service de Santé, bien souvent *dans d'autres circonstances qu'à l'extrême-avant*. Il s'agira de l'évacuation de patients des hôpitaux chirurgicaux mobiles et des hôpitaux d'évacuation mobiles ou semi-mobiles, situés dans les secteurs divisionnaires, vers des formations de traitement définitif ou des formations de traitement

spécialisé, situées dans la zone des armées ou vers des terrains d'aviation en vue d'une évacuation par avion à grande distance. Les risques au cours de ces évacuations sont variables. Ils sont fonction de la supériorité aérienne du moment. Ils seront surtout constitués par l'éventualité d'une attaque-surprise, effectuée par un avion de chasse ennemi isolé ou une patrouille aérienne ennemie, en mission d' 'intruder' à basse altitude. Si l'identification de la mission sanitaire en cours, grâce à une signalisation lumineuse appropriée, est réalisée, une attaque dirigée contre un hélicoptère ne peut plus avoir aucune justification ni excuse puisque l'équipage de l'hélicoptère ne peut, dans la zone qu'il survole, se livrer à l'observation des lignes des mouvements de l'ennemi: il en est beaucoup trop loin.

Au fur et à mesure que les missions d'évacuation sanitaires sont plus éloignées de la zone des combats et de la zone de l'avant, les risques de ces attaques-surprises se réduisent dans des proportions considérables, mais non pas à un point tel que l'on puisse négliger totalement une protection juridique.

2. Il en va tout autrement *dans la zone de l'avant* ou dans les régions à front mouvant ou encore dans des régions tenues par des groupes de partisans ennemis se livrant à la guerrilla. L'hélicoptère, comme tout aéronef, sera toujours considéré par les combattants comme un magnifique observatoire, ayant vue vers l'avant quand il se trouve à proximité des positions adverses. Même s'il est porteur de la croix-rouge, les belligérants admettront difficilement cette possibilité d'observation et de recueil de renseignements que permettrait l'accomplissement de la mission sanitaire. Au surplus, à ces mêmes circonstances, déjà par elles mêmes dangereuses, de relève et transport au contact de l'ennemi, risque de s'ajouter un nouvel élément, dû aux évolutions à basse altitude de l'hélicoptère. Si celles-ci sont interprétées comme recherche des blessés, l'ennemi est en droit de refuser l'immunité à l'appareil. En effet, le Commentaire de Genève de 1949, publié sous la direction de Monsieur J. Pictet, cité plus haut, déclare:

'Pas plus qu'en 1929, on n'a jugé possible d'immuniser des avions qui procéderaient à la recherche des blessés et cela pour des raisons de sécurité militaire.' (Tome I, p. 320.)

Comme l'article 36 dont il s'agit parle d'aéronefs sanitaires et non pas d'avions, ce commentaire s'applique également, en bonne logique aux hélicoptères. On peut se demander ce qui reste de la protection conférée par l'article 36 à un hélicoptère sanitaire volant à basse altitude, à portée des armes des éléments ennemis, dans l'accomplissement de sa mission puisque la plupart de ses manoeuvres, et surtout celles préparatoires à l'atterrissage, peuvent faire l'objet d'une interprétation de recherche de blessés.

Les conclusions découlant de ces considérations nous paraissent nettes.

(a) *Le survol des territoires ennemis, des zones ou des positions occupées par l'ennemi* sera toujours denié aux hélicoptères. Il est inutile d'envisager cette éventualité dans un statut protecteur international. On court au devant d'un échec certain. Le troisième alinea de l'article 36 prévoit d'ailleurs que, sauf accord contraire, le survol du territoire ennemi ou occupé par l'ennemi sera interdit.

Nous croyons qu'il est important d'introduire dans le texte du futur statut cette réserve de l'accord contraire. En effet, un tel accord peut jouer dans les circonstances particulières, (position encerclée par exemple) et permettre l'évacuation des

blessés en survolant des lignes ennemies. Ce serait l'équivalent des cartels qui autrefois, aux 16 et 17 siècles eurent à leur actif maintes interventions charitables en faveur de blessés militaires des places fortes assiégées.

(b) En ce qui concerne les *missions à l'extrême avant*, à proximité immédiate des unités au contact de l'ennemi, sur quelle base peut-on fonder les limites de la protection juridique des hélicoptères sanitaires? C'est évidemment ici que se trouve un des points les plus délicats du futur status envisagé. Pour éviter des abus, il n'est pas possible de conférer la garantie de l'immunité aux hélicoptères en mission sanitaire pendant le survol des zones de contact des unités de combat des belligérants.

Toutefois, cette notion de *zone de contact* des unités de combat exige des précisions.

Le Commentaire de la Convention de Genève No. 1 (Pictet J. - Tome I p. 320) stipule: 'Les aéronefs sont assimilés, comme les véhicules sanitaires terrestres, à des formations mobiles'.

Or, la protection des formations sanitaires mobiles est réglée par les articles 19, 21 et 22 de la Première Convention. En transposant aux hélicoptères sanitaires, les conditions exigées pour la garantie du respect et de la protection accordée par ces articles, il semble que l'on puisse trouver une base raisonnable d'interprétation et de solution.

En s'inspirant de l'article 19, on peut exiger que: 'les autorités compétentes veillent à ce que les missions secourables confiées aux hélicoptères sanitaires ne se déroulent pas, là où des attaques éventuelles ou en cours contre des objectifs militaires peuvent mettre ces aéronefs sanitaires en danger'.

En s'inspirant de l'article 21, on peut aussi considérer que 'la protection due aux hélicoptères en mission sanitaire ne pourra cesser que s'il en est fait usage pour commettre, en dehors de leurs devoirs humanitaires, des actes nuisibles à l'ennemi. Toutefois, la protection ne cessera qu'*après sommation* fixant, dans les cas opportuns, un délai raisonnable et qui serait demeurée sans effet'. Parmi les actes nuisibles à envisager ici, il faut évidemment placer en tout premier lieu le repérage et l'observation des positions et des mouvements de l'ennemi.

On est bien forcé de constater que si l'on désire écarter les reproches justifiés d'abus, la relève des blessés dans la zone des combats est condamnée à demeurer le plus souvent ce qu'elle a toujours été: un acheminement lent et pénible du blessé vers un poste de secours par des brancardiers qui se dissimulent au mieux et se mettent, comme ils le peuvent, à l'abri des feux.

On peut regretter que cette relève se fasse dans des conditions si laborieuses, si dangereuses et si lentes alors que l'on dispose d'une machine volante dont les caractéristiques sont idéales pour simplifier et accélérer l'évacuation des blessés graves. Mais ces regrets ne changent rien au fait que l'hélicoptère, lorsqu'il est une cible à vue directe pour l'ennemi, est aussi, à ce moment, le plus souvent, un observatoire potentiel des positions et des mouvements de cet ennemi. Si l'on peut déplorer l'impossibilité de faire tomber toutes les restrictions qui entravent la protection juridique de l' 'ambulance', il faut reconnaître que la présence d'une voiture d'ambulance se déplaçant sur une crête en vue de l'ennemi ou y stationnant, avec vue plongeante sur les positions de cet ennemi serait, elle aussi, dificilement tolérée par ce dernier en application de l'article 35.

Ces considérations n'ont envisagé, en ordre principal, que les aspects de l'emploi sanitaire des hélicoptères en fonction des impératifs militaires et de ceux de la tactique sanitaire. Certes, les propositions émises n'aboutiront dans la pratique qu'à l'octroi d'une protection encore imparfaite des missions sanitaires confiées à l'hélicoptère, puisque celles de l'extrême-avant, au contact même de la ligne de feu, seront souvent exclues de cette protection, en raison de la situation tactique. Mais ces limites auront l'avantage d'être précisées par des textes. La situation sera donc claire. Les missions juridiquement protégées représenteraient d'ailleurs la plupart des missions que l'on demandera en temps de guerre ou de conflit armé aux hélicoptères mis à la disposition du Service de Santé. Celles qui s'excluraient d'elles-mêmes du bénéfice de la protection juridique sont certes les plus spectaculaires, celles qui relèvent le plus souvent de la prouesse. Il faut néanmoins admettre qu'elles sont assez réduites en nombre.

Pour certains cas très exposés de l'extrême-avant, il appartiendrait aux Etats-Majors et à leurs conseillers médicaux, à défaut d'une protection juridique, d'en faire assurer la protection par les moyens armés, aériens ou autres, ou de prendre le risque calculé inhérent à toute opération de guerre.

(c) Il se peut qu'une hélicoptère sanitaire, en mission dans une zone de contact des unités de combat des belligerants, survole un territoire ennemi ou occupé par l'ennemi, à la suite d'une méprise sur sa position réelle ou sur celle de l'ennemi. Dans ce cas, il n'est pas possible de contester à ce dernier la légitimité d'un contrôle.

Le statut de protection doit néanmoins prévoir le *respect de l'appareil*, tout en lui imposant d'obeir à toute sommation d'atterrir ou d'amerrir. Il y aura également lieu de prévoir, en cas d'atterrissage imposé ou fortuit, le sort des malades et des blessés, ainsi que celui de l'équipage, du personnel sanitaire et de l'appareil selon la catégorie dont relève ce dernier.

Des dispositions similaires doivent aussi être prévues pour le cas de survol du territoire des Puissances neutres, accompagné ou non d'escale, d'atterrissage fortuit ou par sommation..

Telles sont, selon nous, les bases essentielles permettant de reconsidérer la place de l'hélicoptère sanitaire dans le cadre du statut juridique protecteur revisé et modernisé de l'aéronef sanitaire.

En résumé, les propositions contenues dans ces conclusions tendent à apporter des modifications en profondeur dans le concept et les textes du status actuel puisqu'elles touchent aux quatre domaines fondamentaux suivants:

(i) la définition précise des appareils protégés qui sont:

(1) des hélicoptères sanitaires au sens strict, c'est-à-dire ceux affectés en exclusivité et en permanence au service sanitaire et

(2) des hélicoptères occasionnellement et temporairement en mission sanitaire.

(ii) la signalisation de ces deux catégories d'hélicoptères protégés: outre le signe distinctif des Conventions de Genève, ils devraient disposer d'un système visuel direct de signalisation lumineuse en tous temps et à toute distance, qui permette de respecter leur immunité.

(iii) la suppression de tout accord préalable entre belligérants concernant le plan de vol des hélicoptères sanitaires.

(iv) les modalités de leur emploi en mission sanitaire et surtout leurs zones d'opérations. Sauf accord spécialement conclu, les hélicoptères sanitaires ou en mission sanitaire ne pourront survoler le territoire ennemi, le territoire occupé par l'ennemi et les zones de contact des unités de combat des belligerants. En cas de survol d'une zone interdite, l'hélicoptère ne sera pas l'objet d'une attaque, mais pourra être sommé d'atterrir.

En cas d'atterrissage fortuit ou imposé sur les territoires précités ou en pays neutre, les hélicoptères sanitaires au sens strict ne pourrait être saisis qu'à la condition d'être utilisés par le capteur à des fins exclusivement sanitaires. Les appareils des Institutions Internationales devront être remis à la disposition de celles-ci avec leur équipage.

3. PROJET DE NOUVEAU STATUT JURIDIQUE DE L'AVIATION SANITAIRE

Constater des lacunes est une chose. Faire des propositions constructives et cohérentes pour les combler est une autre chose. C'est souvent la plus difficile. C'est le cas certainement pour l'immunisation des transports aériens sanitaires en général et celle des évacuations sanitaires par hélicoptère en particulier.

Mal posé en 1929, le problème ne peut recevoir de vraie solution sur la base des textes de 1929 et de 1949

Dans certains milieux militaires, l'importance de cette question est parfois contestée. Il est vrai que, dans les conflits des 30 dernières années, pour autant que les missions sanitaires aériennes effectuées dans le cadre du transport militaire respectaient certaines principes opérationnels, elles n'ont pas fait courir un rsique déraisonnable aux blessés. Mais ces règles sont loin de pouvoir toujours être suivies. C'est surtout le cas quand on envisage les conditions où l'on désire employer les hélicoptères légers et les hélicoptères lourds dans les zones de combat, avancées et arrières et dans les opérations de contre-guerrilla.

Aussi la situation a-t-elle ému des autorités des Services de Santé militaires, les Sociétés de Droit International médical, et, dernièrement, le Comité International de la Croix-Rouge.

Ce dernier, après la parution en 1965 de l'étude mentionnée plus haut où j'avais déjà développé les arguments exposés ci-dessus, a demandé à la Commission médico-juridique de Monaco de l'examiner et de préparer un projet de dispositions ayant pour but de régler, sous la forme d'une revision des Conventions de Genève ou d'un accord spécial qui serait annexé à leur texte actuel, un status d'immunité de l'aviation sanitaire en temps de conflit.

Le texte élaboré par la Commission médico-juridique de Monaco s'adresse aux conditions d'emploi, non seulement des hélicoptères sanitaires et des hélicoptères en mission sanitaire, mais encore aux conditions d'emploi des aéronefs sanitaires en général.

Il répond aux idées qui font l'objet de cet exposé. Il figure in extenso en annexe. Il est l'oeuvre de médecins et de juristes spécialisés en droit international. Il constitute une réadaptation du status aux caractéristiques techniques et opérationnelles de la guerre aérienne moderne.

S'il vient à être accepté, faut-il conclure que toutes les difficultés seront aplanies pour autant?

Il est à présumer que non.

Pour qu'une formule de protection ait des chances d'être appliquée en temps de guerre, deux choses sont indispensables.

(a) *D'abord, la confiance des parties contractantes* à l'égard d'un statut international protégeant dans le cadre des limites fixées toutes formes de missions sanitaires aériennes. La confiance se donne ou se refuse. En temps de guerre, elle est toujours fragile. C'est une raison de plus pour essayer de la bâtir avant tout sur une conception nette des réalités techniques et militaires de la guerre moderne. La bonne volonté est nécessaire, mais elle ne suffit pas. Négliger ces réalités serait bâtir sur le sable, comme on le fit en 1929 et en 1949.

(b) *En deuxième lieu, chez les deux belligérants en présence, le souci du droit de la guerre et des conventions humanitaires internationales.* Or, la rédaction des Conventions humanitaires et des statuts particuliers qu'elles contiennent est dominée par une conception européenne conventionnelle de la guerre, qui remonte pour le moins au 18e siècle. A côté d'elle, un nouvel art de la guerre se développe sous nos yeux: mise en application dans des pays du Tiers - Monde, la nouvelle conception de la guerre revolutionnaire poursuit ses objectifs en ne recourant qu'à la guerilla et en supprimant la distinction nette qui a toujours existé entre les civils et les militaires, les non-combattants et les combattants. Dans une telle conception de la guerre, le belligerant qui en suit les principes se préoccupera-t-il d'observer à l'égard de l'autre une convention qu'il n'a pas signée puisqu'il n'en avait pas la faculté, et dont il pourra toujours dire, par conséquent, qu'elle ne l'engage pas?

Ainsi donc, alors que tout permettait de croire que les lacunes à combler dans l'établissement d'un statut moderne de l'hélicoptère sanitaire ne relevaient que de certains aspects purement techniques de la guerre aérienne et des conceptions d'emploi des aéronefs, on se trouve ramené, devant les textes juridiques des conventions, à ce problème vieux comme la guerre: la bonne foi des parties dans le respect des traités et des principes qui font honneur à l'humanité, même au sein de la guerre et dans l'atmosphère des combats.

Sous ce rapport, nous ne pouvons rien faire, nous les médecins et les techniciens.

Malgré les limites de notre tâche, nous croyons néanmoins que le texte qui vient d'être soumis au Comité International de la Croix-Rouge par la Commission médico-juridique de Monaco et qui tient largement compte, dans sa concision, des idées et des réalités qui ont été développées ci-dessus, contribuera en fin de compte à donner, un jour, une solution meilleure parce que plus réaliste, au statut international juridique de l'hélicoptère sanitaire dans le cadre des Conventions de Genève.

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ANNEXE 1*

Spécification des Moyens Complémentaires d'Identification des Aéronefs en Mission Sanitaire

1. SIGNAUX LUMINEUX

Couleur: rouge

Nature: feux intermittents sous forme de flashes

Fréquence du clignotement: 60 éclats par minute

durée d'un éclat: 0,5 seconde

pause d'un éclat: 0,5 seconde

Puissance: 500 watts au minimum

Emplacement: (a) *avion*: à l'avant du fuselage un peu en dessous du nez de l'appareil

(b) *hélicoptère*: à l'avant du fuselage, face inférieure.

Pour les deux types d'aéronefs, le faisceau lumineux est dirige en bas dans le sens normal de translation de l'appareil et forme avec l'axe longitudinal de l'aéronef un angle de 75 degrés et avec l'angle de lacet un angle de 15°.

2. RADAR SECONDAIRE (SIF)

Mode: 3A

Code: réserver un code à définir, par accord international, dans le mode 3A.

3. RADIO

Reserver une fréquence UHF, a définir par accord international, sur laquelle les aéronefs en mission sanitaire émettent pour signifier la presence exclusive de blessés à leur bord.

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* Cf. article 4, Section 2, du 'Projet de Règles relatives aux transports sanitaires par voie aérienne en temps de conflit arme'. (C.M.J.M. resolution I, 4 juin 1966).

ANNEXE 2

Commission Médico-Juridique de Monaco

Vème Session

1. PROJET DE REGLES RELATIVES AUX TRANSPORTS SANITAIRES PAR VOIE AERIENNE EN TEMPS DE CONFLIT ARME

CONSIDERANT que le principe du respect en toutes circonstances des blessés, malades et naufragés des Forces armées est un principe fondamental des Conventions humanitaires de Genève et qu'il importe d'en assurer l'application avec le maximum de moyens et d'efficacité;

CONSIDERANT que cette préoccupation majeure devrait inciter les Gouvernements à compléter les dispositions des Conventions du 12 août 1949, soit à l'occasion d'une révision de celles-ci, soit, sans attendre cette revision, par le moyen d'un accord complémentaire à conclure sous la forme d'un Protocole annexé;

Que l'action ainsi recommandée aurait pour but en temps de conflit armé:

1. de développer par l'utilisation d'un plus grand nombre d'appareils, le transport aérien des blessés et malades et du personnel et du matériel sanitaires;

2. de garantir au maximum la sécurité des transports utilisés à cette fin par une réglementation technique et juridique appropriée;

CONSIDERANT que les progrès techniques accomplis dans le domaine des transmissions et des télécommunications intéressant la navigation et la défense aériennes permettent d'affecter aux aéronefs utilisés à des fins sanitaires des moyens d'identification et de signalisation susceptibles de renforcer l'effet de sauvegarde des signes traditionnels de protection;*

PERSUADEE, d'autre part, de la nécessité de libérer l'emploi des aéronefs en mission sanitaire de l'obligation actuellement prévue dans les Conventions d'établir au préalable un plan de vol agréé par les belligérants intéressés, en raison des difficultés inhérentes aux circonstances mêmes des hostilités;

La Commission médico-juridique de Monaco souhaite que soient entreprises les démarches nécessaires pour obtenir la mise en oeuvre des règles suivantes.

Article 1er

Les aéronefs militaires des Parties au conflit, utilisés temporairement mais en exclusivité, pour l'évacuation des blessés et des malades et le transport du personnel et du matériel sanitaires, ne seront pas l'objet d'attaques mais seront respectés et protégés pendant toute la durée de leur mission.

* Tous moyens suggérés par l'article 36, alinéa 2 de la Convention I de 1949.

Article 2

Seront respectés et protégés en toutes circonstances les aéronefs qui seront exclusivement affectés, dès le temps de paix ou au cours des hostilités, aux services de santé des armées.

Indépendamment des aéronefs d'Etat spécialement aménagés à cet effet, les aéronefs civils de toutes catégories pourront être transformés, au début ou au cours des hostilités, en aéronefs sanitaires, à la condition de ne pas être désaffectés pendant toute la durée du conflit.

Les Puissances neutres, les Sociétés Nationales de la Croix-Rouge, les Sociétés de Secours officiellement reconnues, pourront mettre des aéronefs sanitaires à la disposition d'une ou des Parties au conflit.

Article 3

Les aéronefs des Organisations intergouvernementales, des Instituts spécialisées des Nations Unies, du Comité International de la Croix-Rouge qui seraient affectés aux fins précitées, seront également respectés et protégés en toutes circonstances.

Article 4

Les aéronefs visés aux articles précédents porteront ostensiblement, le signe distinctif de la croix rouge sur fond blanc (croissant, lion et soleil).

Ils seront dotés, en outre, en fonction des circonstances de leur emploi, d'un système permanent de signalisation optique lumineuse ou d'identification instantanée électrique et radio-électrique*, ou éventuellement des deux.

Article 5

Est interdit aux aéronefs visés par les présentes dispositions le survol du territoire ennemi, d'un territoire occupé par des forces ennemies terrestres ou navales et des zones de contact des unités de combat des belligérants.

Toutefois des dérogations pourront être admises en application d'un accord spécialement conclu par les Parties au conflit, entre elles ou avec un organisme international.

Article 6

Les aéronefs visés par les présentes dispositions, survolant un territoire ennemi ou occupé par l'ennemi, seront respectés mais devront obéir à toute sommation d'atterrir ou d'amerrir.

En cas d'atterrissage, fortuit ou imposé, sur les territoires précités et à moins d'un arrangement contraire entre les Parties au Conflit, les blessés et malades transportés pourront être faits prisonniers de guerre. Le personnel sanitaire, ainsi que l'équipage, seront traités conformément aux règles de la présente Convention†.

* Voir annexe.

† Cf. Convention I, Article 24 et suivants.

Les aéronefs visés à l'article 2 ne pourront être saisis qu'à la condition d'être utilisés par le capteur à des fins sanitaires.

Les aéronefs visés à l'article 3, ainsi que tout le personnel à bord, seront autorisés à poursuivre, après vérification, leur mission.

Article 7

Les aéronefs visés par les présentes dispositions pourront survoler, en cas de nécessité, le territoire des Puissances neutres et y faire escale. Ils devront signaler à la Puissance neutre leur passage et obéir à toute sommation.

Toutefois, la Puissance neutre pourra fixer les conditions ou restrictions tant au survol de son territoire qu'à l'atterrissage sur celui-ci. Ces conditions ou restrictions seront appliquées d'une manière égale à toutes les Parties au conflit.

Article 8

Au cas d'atterrissage en pays neutre, par nécessité ou sur sommation, l'aéronef pourra repartir avec ses occupants, après contrôle éventuel exercé par la Puissance neutre. Il ne pourra être retenu que dans les cas où ce contrôle aura permis de constater des actes incompatibles avec la mission humanitaire de l'appareil.

Les blessés ou malades débarqués avec le consentement de l'autorité locale devront, à moins d'un arrangement contraire de l'Etat neutre avec les Parties au conflit, être gardés par l'Etat neutre lorsque le droit international le requiert, de manière qu'ils ne puissent pas de nouveau prendre part aux opérations de guerre. Les frais d'hospitalisation et d'internement seront supportés par la Puissance dont dépendent les blessés et les malades.

Si l'appareil ayant atterri en territoire neutre n'est pas en conditions de repartir, son équipage et le personnel sanitaires seront restitués.

Pour les appareils, équipage et personnel sanitaires appartenant a un pays neutre, seront appliquées les règles générales de la Convention concernant les droits et devoirs de Puissances et des personnes neutres en temps de guerre.

N.B. Les articles 39 et 40 de la IIème Convention devront être remplacés par des dispositions analogues.

L'article 22 de la IVème Convention devrait être modifié le même sens.

DISCUSSION

Brig.Gen.Lauschner asked whether the Geneva Convention would extend to the protection of search and rescue helicopters operating over water. Maj.Gen.Evrard replied that he felt that this would be very hard to achieve since it would be very hard to differentiate between such operations and anti-submarine operations. In reply to an enquiry about the value of the Monaco Conference, Maj.Gen.Evrard stated that the most difficult problems, particularly those of definition of zones and identification had been solved at that meeting.

HELICOPTER AIR AMBULANCE PROBLEM AREAS

by

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RESUME

Examen des problèmes posés par l'utilisation des hélicoptères affectés au rôle d'ambulance aérienne. Ces problèmes sont particuliers à chaque cas plutôt qu'à l'hélicoptère employé en tant que véhicule d'évacuation. Parmi ceux-ci, citons: le manque de communications standardisées air-sol en situation tactique, d'où difficulté d'identification des forces alliées et délais d'évacuation; l'entraînement insuffisant aux conditions de vol sur hélicoptère (choix du lieu d'atterrissage, possibilités de l'appareil); l'inaptitude à discerner les dangers tactiques aériens par rapport aux situations terrestres.

HELICOPTER AIR AMBULANCE PROBLEM AREAS

Major F.J.Mills, MSC

1. INTRODUCTION

It is universally recognized that the helicopter as a patient evacuation vehicle, a means to transport vital medical teams, and a medical re-supply vehicle is an intrinsic part of modern military medicine. The flight characteristics of the helicopter provide a versatility that is unsurpassed at this date. However, there are problem areas involved in the employment of helicopters designated as air ambulances. The problems are peculiar to individual situations rather than to the helicopter as an evacuation vehicle.

Some of those areas, which I hasten to add are not insurmountable are: air-to-ground communications in a tactical situation, the employer's (evacuation requestor) lack of helicopter education and the employment of designated helicopter air ambulances as tactical vehicles rather than as ambulances. The reasons that these are problems that particularly affect the air ambulance units is that the majority of the evacuation flights are single aircraft missions and not multi-aircraft assault type missions.

The mentioned problem areas are prominent and will be discussed in more detail at this time.

2. AIR-TO-GROUND COMMUNICATIONS IN A TACTICAL SITUATION

(a) Language barriers are a problem when participating in joint operations with allied nations. Although tactical maneuvers are jointly planned thoroughly, experience has proved that the classification of patients, i.e., urgent, priority and routine, is not thoroughly understood by all participating units, thus causing improper utilization of air ambulances.

(b) The lack of standardized communication equipment for ground and air units.

  (i) Separate patrols that might request an air ambulance, in many instances, will be equipped with radios incompatible with the aircraft communications system thus creating the problem of positive air-to-ground identification of friendly troops.

  (ii) This problem also causes the reaction time for the patient extraction to be extended since the requestor usually does not have direct communication with the air ambulance unit. This pertains to the small isolated units rather than to units of company size or larger.

3. LACK OF HELICOPTER EDUCATION

The extensive utilization of helicopters, in its infancy, has proved that there is a marked lack of knowledge on the part of ground troops concerning the capabilities of the helicopter. Specific areas are as follows:

(a) Selection of landing areas.
- (i) The degree of slope.
- (ii) The height of barriers.
- (iii) The overall length of individual helicopter types and their rotor diameters.
- (iv) The lift capability of specific types of helicopter.

(b) General knowledge of the aerodynamics of the helicopter.

(c) Failure to recognize tactical aerial hazards as compared to the ground situation.
- (i) Approach routes over unfriendly territory.
- (ii) The security of the landing zone.
- (iii) Aerial identification of landing zones.

4. EMPLOYMENT OF HELICOPTERS DESIGNATED AS AIR AMBULANCES

Helicopter air ambulances, because of their mission, should be utilized exclusively in the role of patient evacuation, the transportation of vital medical teams and medical re-supply. The tactical situations that necessitate immediate employment of aircraft probably will require immediate patient evacuation also. If the designated helicopter ambulances are deployed as tactical vehicles, then, needless to say, the air ambulance's primary mission of patient extraction is neglected and lives are lost.

5. CONCLUSIONS

The problems of helicopter ambulance units are wide and varied, as in any aviation unit. However, air-to-ground communications, lack of helicopter education, and improper utilization of evacuation aircraft are important problems that are encountered. These problems are not insurmountable and are in the process of being eliminated during the normal day-to-day operations. The concept of helicopter evacuation is established and its goal is to provide a better medical service to the patient. Thus, by eliminating the mentioned problems, future helicopter ambulance units will be more effective. Also, the ultimate goal of the Army Medical Service and Army Aviation will be combined to "Conserve the Fighting Strength Above the Best".

DISCUSSION

Lt Cdr Williams enquired about the mode of communication between the troops in the field and the helicopter ambulance. Was this direct or through a base controller? In his experience commanders always wanted, rightly, to retain control of air movements. Major Mills replied that in his type of unit control was exercised by the medical group commander who in fact was the surgeon in control of the whole operation.

Lt Cdr Williams asked whether it was felt that the display of the red cross was sufficient identification for protection of specifically detailed helicopter ambulances. Brig.Gen.Lauschner replied that this seemed unlikely. He wished to emphasize that it was only possible to use the helicopter as an air ambulance in an extensive manner if the operating country had complete air superiority.

HELICOPTER EVACUATION IN VIETNAM

by

Lt Col E.Lail, MSC

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RESUME

Etude des opérations d'évacuation de blessés au Vietnam par des unités ambulancières d'hélicoptères appartenant au Service Médical de l'Armée de Terre. Description des hélicoptères, de l'équipage et du matériel actuellement utilisée en Asie du Sud-Est en renfort des forces anti-insurrectionnelles. Comparaison des avantages et des inconvénients de la compagnie d'ambulances aériennes et du détachement d'ambulances aériennes. Etude du soutien général par rapport au soutien direct, avec description d'une demande typique d'évacuation, et de l'exécution de l'opération par l'équipage d'une ambulance aérienne. Les statistiques d'évacuation, l'accroissement des missions de soutien direct et des opérations de hissage, et la fréquence des "escortes de canonnières" laissent pressentir une augmentation future des activités pour les unités d'évacuation par hélicoptères au Vietnam.

HELICOPTER EVACUATION IN VIETNAM

Lt Col E.Lail, MSC

Today in the Republic of Vietnam, history is being rewritten again by one of the finest military medical teams in the world, that of the United States Army Medical Service (AMEDS). A member of that team is the Army Medical Service air ambulance helicopter and its crew. It was in Korea that AMEDS helicopter evacuation became a reality, not as the result of any preconceived plan but rather the result of expediency. In the early days of the conflict, helicopters were called upon to evacuate seriously wounded casualties from the extremely difficult terrain. Hence the beginning of a more rapid and efficient means of patient evacuation. From a very meager beginning with the OH-13, we have progressed to the helicopter authorized today - the UH-1D.

The UH-1D helicopter, manufactured by the Bell Helicopter Company, is a military type aircraft of compact design, featuring a low silhouette and low vulnerability to meet combat requirements (Fig.1). A wide cargo-passenger-patient compartment, with large cubic foot volume, permits the helicopter to be used in a variety of services; for the transport of personnel, special teams, supplies and equipment, and for aeromedical evacuation of casualties. This helicopter is capable of operating from unprepared take-off and landing areas and under instrument conditions by day or night. It can also be used to navigate by dead reckoning or by use of radio aids to navigation. Maximum visibility is afforded the pilot and crew by use of transparent plastic panels at the top, front, bottom and sides of the cabin.

The helicopter is equipped with the T53-L-11 turbine engine located aft of the cabin and mounted on a platform deck to provide maximum accessibility for servicing and maintenance. This engine is a free turbine type designed for low fuel consumption, minimum size and weight, and maximum performance.

Provisions for the installation of folding litter racks adapt the UH-1D helicopter to carry six litter patients. Three standard Army Service litters are located on each side of the transmission support structure. An alternate litter loading is to position three litters laterally in front of the transmission. In this configuration, four ambulatory patients can also be carried.

When six litters are installed, the center forward facing troop seat is used for the medical attendant. When lateral litter loading is used, a single seat attached to the floor behind the pilot or copilot and facing aft is used for the medical attendant.

Two blood-bottle hangers have been provided on the inside of the cabin roof structure within easy reach of the medical attendant for administration of blood to litter patients in flight. There are six electrical receptacles provided to furnish 28 volt direct current for heated blankets. Although not a part of the aircraft equipment, a resuscitator is available for those patients requiring this specialized piece of

equipment. In addition, the air ambulance aidman has available to him a telescopic splint set and an individual surgical instrument and supply set for enroute care of the patient.

The crew of an air ambulance consists of an aircraft commander, pilot, crew chief and aidman. The aircraft commander is responsible for all aspects of the evacuation and must be thoroughly competent in both the medical and aviation aspects of the operations. He must be completely oriented to the general and specific medical mission and have a thorough knowledge of the detail plan of evacuation. He must also be familiar with the capabilities and the limitations of the varied patient treatment facilities utilized by the Army Medical Service. Pilot personnel attend a special four weeks course of instruction entitled "Essential Medical Training for AMEDS Aviators". This course prepares the aviator for the medical tasks and decisions he will encounter on a medical evacuation mission. This crew is extremely well trained, having received formal instruction in shock and hemorrhage, maintenance of airway, injuries of the head, chest and abdomen, burns, and emergency treatment procedures.

The Army Medical Service is currently authorized air ambulance Companies and Detachments.

The Company is operationally self-sufficient and is capable of providing aeromedical evacuation of patients from as far forward as the tactical situation will permit, expeditious delivery of critically needed medical supplies and transportation of key medical personnel throughout the combat zone. The company consists of four air ambulance platoons, each equipped with six UH-1D helicopters. Each platoon, when augmented by maintenance and airfield service personnel, can operate in a separate location. However, the dispersed platoons remain dependent upon the company headquarters for administrative support.

The Detachment is not operationally self-sufficient, in that it does not have a food service section and must depend on an adjacent unit for this support. This unit has the same capability as one platoon of the Company. However, it has the distinct advantage of being able to take care of its own administration.

Air ambulances in Vietnam provide both direct (unit) and general (area) support to combat forces in that war-torn country. The direct support air ambulance goes with the deployed battalion or brigade and is responsive only to requests from that unit. This decentralized control permits quick reaction time but does not maximize the use of air ambulance helicopters. Air ambulances controlled at a higher level are responsive to more units and better utilization is therefore attained.

Requests for an aeromedical evacuation must include certain information for it to be processed expeditiously. This information will include:

Coordinates of the pick up site.

Number of patients and their condition.

Category (URGENT, PRIORITY, ROUTINE).

Tactical radio frequency.

Other, such as tactical situation, special equipment required.

The category classification is particularly important. An *Urgent* classification means that the wounded individual must be evacuated immediately in order to save life or limb. This request will receive the quickest response possible from the evacuation unit. The helicopter will usually be off the ground within three minutes after the air ambulance unit has been notified of the evacuation request. The *Priority* request is less urgent and must be evacuated within 24 hours. The *Routine* evacuation request will be responded to within 72 hours.

This system of classifying patients permits the headquarters controlling air ambulance evacuation to employ its resources more effectively and to make certain that air ambulances are always available to evacuate those patients requiring an Urgent evacuation.

The Vietnam story is replete with factual accounts of the many life saving missions flown by the helicopter. It has been said that a soldier wounded in combat in the Republic of Vietnam has a better chance of receiving first class medical care more quickly than a motorist injured in a highway accident in the United States. No injured soldier in Vietnam is more than 35 minutes away from a well equipped medical facility. This is due to the rescue helicopters that the Army first tried during the Korean war and now uses in large numbers in Vietnam.

The mortality rate among wounded in Vietnam is the lowest in recorded history of armed conflict. By applying classic military medical doctrines and utilizing new operative and evaluative techniques the following have been achieved; the fatality rate among all wounded reaching hospital facilities in Vietnam is 2.4% as compared with the 2.5% in Korea, 4.5% in World War II, and 8.1% in World War I.

The United States Army now has some 61 helicopters with medical crews flying about 5,000 sorties a month while evacuating just over 8,000 United States, Third Country, and Vietnamese wounded per month. During calendar year 1966, these 61 helicopters evacuated more than 64,000 casualties while flying some 33,000 combat hours. Approximately 25% of these were Vietnamese patients and approximately 5% were from other countries. These impressive statistics were made with an aircraft availability of around 75%. There have been problems however. The previous speaker (Major Mills) has alluded to the major ones.

Because of the unprecedented use of the helicopter in this conflict, there is an ever greater need for the combat troops to be aware that the helicopter does indeed have certain limitations. For example, it can carry just so many patients during any one lift, and this will be determined by the surrounding terrain and climatic conditions. In the heat of combat and because of the urgency to remove the wounded from the battle-field this is sometimes overlooked. This same sense of urgency (and it is not imagined urgency) often leads the requestor to call an air ambulance before the wounded are collected, or into an area too small for the helicopter, or before that area is secure.

One new item of equipment in the air ambulance units is being used to extract wounded from areas inaccessible to the helicopter. Provisions have been made for the installation of an internal personnel rescue hoist (Fig.2). This installation may be made in any one of four positions in the helicopter cabin. The hoist installation consists of a vertical column extending from the floor structure to the cabin roof, a boom, and an electrically operated winch. Two electrical controls for the operation of the rescue hoist are provided, one for the pilot, and one for the hoist operator. The pilot's

control switch is located on the cyclic control stick and provides up and down operation of the hoist as well as positioning the boom. The pilot can override the hoist operator's control. An electrically operated ballistic charge type cable cutter is provided with two guarded type switches.

The hoist has a usable cable length of 256 feet which is capable of raising or lowering a maximum load of 600 pounds. The hoist operator has a variable speed control for raising or lowering the cable. The maximum upward speed is 115 feet per minute when fully loaded.

Another item, the forest penetrator, has been made available. This anchor-looking device has three small metal seats which fold down for the less injured to sit on and be hoisted up through the jungle canopy. For the more serious litter patients, a litter hoisting device is available. This gives a certain amount of protection to the patient while he is being hoisted up to the hovering aircraft.

The hoist is being used frequently in Vietnam to remove the wounded which would otherwise take hours to remove. In January 1967 alone, 75 patients were lifted from the floor of the jungle by this item of equipment. This rescue device will undoubtedly be used more and more in the months ahead. Its increased use will require a greater reliance on armed helicopters to protect the rescue helicopter during its critical time of vulnerability while making the actual rescue.

In Vietnam, the helicopter has become a vital, almost indispensable element of front line medical service and patient evacuation. The extremely rugged terrain and lack of a secure road network has made air evacuation an absolute necessity. The Army Medical Service helicopter evacuation system has met the challenge by developing a very high degree of mobility, flexibility and responsiveness in its units.

In the future, Army Medical Service helicopters and their crews will continue to play a vital role in evacuating the wounded from the battlefield. The speed of this means and its insensitivity to terrain make it an essential tool in accomplishing the mission "To Conserve The Fighting Strength".

DISCUSSION

Lt Col Lail wished to add to his own paper some up to date information. The large majority of evacuations in Vietnam were to take from any one site three or less litter cases and four or fewer ambulant patients.

Wg Cdr Fryer asked for more detail in the definition of duties of the four crew members listed by Lt Col Lail. In reply Lt Col Lail stated that the aircraft commander was a pilot with specific training and experience in the role. He was aided by a second pilot, a crew chief who in fact maintained the aircraft and flew in all missions in order to provide field servicing skills, and finally an attendant who was a highly trained medical first-aider.

Fig.1 The UH-1D helicopter

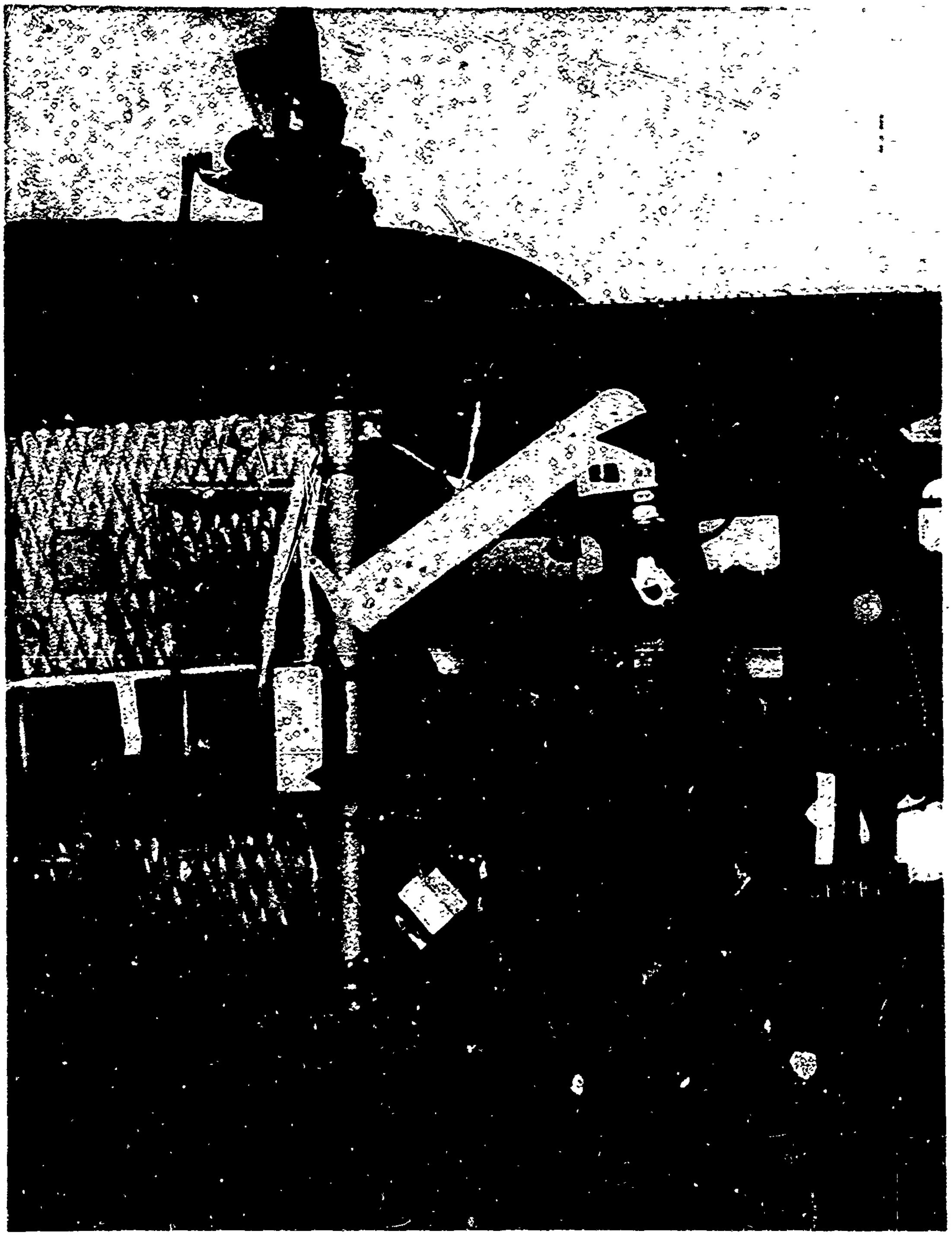

Fig. 2   The UH-1 personnel rešcue hoist

ACUTE CASUALTY HANDLING

by

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RESUME

Le rôle du médecin militaire de troupe dans le triage, et la dispersion des accidentés est décrit dans les conditions operationelles. Trois degrés de priorités pour'evacuation sont proposés et les avantages, et desavantages de transport par hélicoptère ou par route sont discutés.

Les principes de chirurgie militaire et la façon dont ces principes s'appliquent à une équipe chirurgicale de campagne, sont décrit en bref.

ACUTE CASUALTY HANDLING

Major I.Capperauld, RAMC

1. INTRODUCTION

The complex series of pathological changes triggered off by wounding are in a constant state of flux - altering minute by minute and hour by hour. Time is therefore a vital factor in the control of this dynamic state. Marked haemorrhage leads to shock, while handling and mishandling thereafter accentuates this shock and may indeed convert it to an irreversible state. How can valuable time be saved and yet the casualty receive surgical treatment in accordance with fundamental principles? The answer to this depends on the skill and experience of the Regimental Medical Officer who first sees the casualty and the surgeon from the Field Surgical Team who performs the first of a definitive series of operations, backed up by a well organised and smoothly functioning system of evacuation. The main aim of medical units in the field is to relieve the fighting force of the encumbrance of the wounded by clearing them from the battle area. This means however that the state of flux occasioned by wounding is further complicated by the superimposition of the extra handling and movement required by evacuation from the Front Line to the Casualty Clearing Station and hence to the surgeon.

2. THE ROLE OF THE REGIMENTAL MEDICAL OFFICER

Let us consider the part played by the Regimental Medical Officer and the problems he has to face in Casualty handling.

(i) *Casualty Sorting*

This aspect requires a great deal of experience, clinical acumen and skill. He has to decide quickly on the extent of the injuries and classify them as serious or non-serious. He must decide on priorities for treatment on an established triage principle.

(ii) *Casualty Load*

If the numbers of wounded are very great, then his job is to keep clearing his Regimental Aid Post rapidly. His equipment is limited and his time valuable. He is taxed with the responsibility of stopping bleeding, ensuring an adequate airway, splinting fractures, dressing wounds and relieving pain. He must decide on priorities for evacuation.

(iii) *Casualty Dispersal*

He must have a sound knowledge of the routes of evacuation open to his patients and he must decide how best to utilise their potential.

In basic casualty sorting the patients can be readily grouped into one of three categories.

Group 1 Minor injuries which can be treated by a regimental orderly or by the patient himself. Treatment may consist merely of cleansing the wound with an antiseptic and applying an occlusive dressing. The soldier will be able to return to his unit immediately and hence back to duty.

Group 2 Patients with an injury which will not enable them to return to duty but which is not endangering life or limb e.g. burns of the hands and face, simple fractures of the upper limbs. These will require treatment in the Casualty Clearing Station and the patient must be evacuated, not necessarily by the fastest route.

Group 3 Major wounds which will require an operation in the Casualty Clearing Station. Some of these will require rapid evacuation to have surgery performed urgently on them. In this group are patients suffering from shock and who are in need of resuscitation. It is here that the Regimental Medical Officer faces a dilemma. Should he start active resuscitation in his Regimental Aid Post, having tried to halt the progress of shock by stopping haemorrhage, splinting fractures, dressing wounds and relieving pain? By active resuscitation is meant the setting up of an intravenous drip and the replacement of blood loss with Macrodex, Dextran, plasma or blood. How much fluid is he to give the patient? When does he stop giving fluid? Does the half-resuscitated patient travel better than the fully? - or does the patient who has not been started on resuscitative measures at all travel better than one partially resuscitated? What is the index to be used to show the return of circulating volume to normal?

In static centres cannulation of the external jugular vein and transfusion until normal central venous pressure is reached is ideal. So too, is the introduction of red cells labelled with radioactive potassium or chromium and measurement of the blood volume from activity counts. Estimation of blood loss can be done by examination of the clothing, but the modern combat kit is water repellent and does not absorb blood.

Tables have been devised to correlate volumes of blood lost with the size of the hand, a superficial wound being compared to the open hand which is the equivalent of one pint loss, while the deeper wound is measured in terms of the closed fist, which too equals a pint loss. Pulse rates and blood pressures can be misleading as so many factors influence these readings. To be of real value pulse rates and blood pressures must be done as serial readings for comparison. Replacement of fluid by more than 35% of the normal total circulating volume (i.e. an infusion of more than four pints or two litres of a volume expander like Dextran or plasma) dilutes the oxygen carrying capacity of the remaining blood and is also liable to restart haemorrhage which will further deplete the circulation of its oxygen carrying potential. If the Regimental Medical Officer does not resuscitate the patient actively, then irreversible shock may supervene. It is interesting to note the volumes of blood used in the treatment of the wounded in the past. At the end of World War II, 67 pints of blood per 100 wounded was used. In Korea the figure had risen to 90 pints per 100 and in Borneo the figure was up to 150 pints per 100 wounded.

Is irreversible shock then a manifestation of the under transfused? Post mortem examination of patients dying of prolonged shock showed certain cerebral changes and also areas of subendocardial haemorrhage on the left side of the interventricular septum. Muscle and hepatic hypoxia lead to the production of circulating shock-promoting substances which may well prolong shock and make it refractory. At what stage in this dynamic state then should the fight against shock be actively commenced? Should the Regimental Medical Officer resuscitate at once or should he wait until the case comes to the surgeon? The answer to this depends on factors which were previously mentioned, namely casualty load and casualty dispersal.

If the Regimental Medical Officer is swamped with cases then he will not have the time to devote his attention to resuscitation on a large scale, because of sheer numbers. He will have to clear his Aid Post rapidly to make room for more casualties. Paucity of equipment too will determine his efforts, as he usually carries the minimum of resuscitative fluid since it is bulky and weighty. Drips can be difficult to put up under poorly lit conditions and with collapsed veins. He will therefore, under these circumstances, have to depend on Casualty Dispersal and on a Priority Grading that will enable the patient to be taken to the Casualty Clearing Station rapidly. The conventional gradings are as follows.

Priority I Cases requiring resuscitation and urgent surgery. Asphyxia due to respiratory obstruction, for example. This obstruction may well require relief before evacuation and first aid in the form of endotracheal intubation or tracheostomy by the Regimental Medical Officer. Cases of tension pneumothorax or haemothorax interfering with respiration may require needling before evacuation. This can be done by closed system drainage using a two-thirds empty saline infusion bag in reverse as an emergency method to remove the air or blood. Extensive burns require rapid evacuation to the Casualty Clearing Station, wrapped if possible in polyurethane foam. Large muscle wounds and major fractures should be in the hands of the surgeon without delay.

Priority II These patients require early surgery and possibly resuscitiation, e.g. perforations of the gastrointestinal tract and genitourinary tract which are not continuing to bleed severely, and closed cerebral injuries with or without increasing loss of consciousness. The Regimental Medical Officer must ensure an adequate airway in these cases and also must make sure that the correct "coma position" is adopted in transit to the Casualty Clearing Station.

Priority III Includes spinal injuries requiring decompression, and minor fractures and minor wounds requiring the minimal of surgical treatment or surgical toilet.

3. THE MEANS OF EVACUATION

The Regimental Medical Officer, having decided on the priorities, is then faced with how best to disperse his casualties back to the Casualty Clearing Station. Under ideal conditions the patient should be back to the surgeon within six hours of wounding, if he is to get the best out of his surgical treatment. Again in ideal conditions the Regimental Medical Officer has the choice between two methods of evacuation; the helicopter or conventional road transport.

3.1 What Do Helicopters Have To Offer?

1. They provide a more rapid form of evacuation and hence save time. This often means that it is possible to get the patient to the surgeon in under six hours. The less time taken from the wounding to being in the hands of the surgeon also means less time for the dynamic changes of trauma to gain a proper foothold and become established, less time for shock to become prolonged and perhaps irreversible and also less time for infection to establish a nidus.

2. They provide a comfortable journey, since there is no jarring or bumping which to a wounded man mean pain, shock and the restarting of bleeding.

3. Their use allows a reduction in the handling of the patient. The helicopter in the ideal situation can be brought right up to the Casualty Collecting Post and hence eliminates some of the handling which is required in conventional evacuation by road.

4. Their use saves valuable manpower as there is less handling. This potential can be utilised elsewhere.

3.2 What Does Conventional Road Evacuation Have To Offer?

1. It is more time consuming and more traumatic to the patient, perhaps tipping the case with incipient shock into fully established shock.

2. Repeated examination of the patient is performed in this chain of evacuation and any deterioration can be picked up quickly at the Casualty Collecting Posts or by the Field Ambulance at the Advanced Dressing Station. Attempts can then be made to check deterioration by giving intravenous fluids; analgesics can be administered; splints adjusted and bleeding controlled if it has restarted.

There is no doubt which form of evacuation the Regimental Medical Officer would choose for his patient if helicopters were unlimited. However if helicopters are at a premium then he must use them wisely and with discretion. Priority I cases are the classical ones which require helicopter evacuation. Even using helicopters however, the Regimental Medical Officer still must decide how much, if any, resuscitation is required before the patient goes in one hop from front line to surgery, remembering that no checking of bleeding or splinting and no check on deterioration will have taken place in flight. This places a far greater onus on the Regimental Medical Officer than hitherto. He has the task of forecasting rapidly the immediate future of a wounded man caught in the dynamic state of shock and deciding how best to evacuate him.

4. THE CASUALTY CLEARING STATION

The second aspect of Casualty handling starts when the patient arrives at the Casualty Clearing Station and comes under the care of the military surgeon who forms part of the Field Surgical Team. The rest of the team is made up of a Theatre Sister, an anaesthetist, a Medical Officer trained in resuscitation, theatre and laboratory technicians. The task of the surgeon here is simple to state; namely to save life and limb and to

prepare the way for further stages of surgery to take place at base hospital. Unlike his civilian counterpart, the Army Surgeon has to operate under difficult conditions on patients who have often had a rough, tedious journey since their time of wounding. They are often shocked and in need of blood. Depending on the battle area and terrain, their clothing may be mud soaked or heavy with sweat. One of the biggest boons of helicopter evacuation has been the reception of the case by the surgeon within six hours of wounding. This valuable time saved means that infection has not had very long to become established and is worth more to the patient than any antibiotic umbrella started by the Regimental Medical Officer with penicillin and streptomycin. In Borneo the soldier carried capsules of tetracycline which he took if wounded, so as to start antibiotic cover at the earliest possible moment. It is doubtful if absorption from the stomach after wounding would allow a high enough effective circulating level of antibiotic, but this was the best we could offer in the circumstances.

5. MISSILE WOUNDS

What are the principles of Military Surgery applied to the wounded soldier by the Field Surgical Team? It is proposed to deal with missile wounds in this talk, omitting burns and fractures which do not vary much from civilian practice. Missile wounds are divided into two groups.

Low Velocity Missile Wounds. These are usually spent bullets, fragments of shells, mines, rock splinters and grenades. The damage done to the tissues in this form of wounding is usually confined to the tract only.

High Velocity Missile Wounds. In these wounds the area surrounding the tract has been badly damaged by a pressure wave set up by the passage of the missile, which usually blasts the tissues outwards away from the tract. A vacuum is created and on collapse of this blown out tract, infected material from the skin and clothing surrounding the entry and exit wound are sucked into the wound. What may appear at a rapid glance, as a simple through-and-through wound of a limb may appear at operation to involve an area of severe muscle damage to the tissues surrounding the tract larger than a fist. This internal blasting causes intense muscle swelling and may lead to constriction of the circulation of the limb distal to the wound some hours after wounding. It is therefore imperative that proper decompression be carried out. It is important for the Regimental Medical Officer if possible to ascertain the type of missile used in wounding and pass this information on to the surgeon.

6. THE PRINCIPLES OF WOUND CARE

In dealing with the wound itself, the following principles are essential and basic. They have evolved through years of experience of military surgeons and often require relearning at the beginning of each new campaign, when the bitter lessons of past experience have been forgotten.

1. Every wound is contaminated and this contamination increases with the passage of time or with meddlesome interference with dressings which add iatrogenic infection.

2. Patients should be resuscitated fully before operation and additional blood must be available for the replacement of blood lost at operation and for subsequent loss into dressings.

3. Gas Gangrene is an infection of devitalised muscle and hence anything which causes anoxia to the limb will encourage its development. Tight bandages and badly applied splints could lead to gas gangrene. Inadequate excision of devitalised muscle leaves a nidus and if closure of the wound as a primary procedure is performed, then the circumstances are perfect for the onset of gas gangrene.

4. Tourniquets should not be used unless in a dire emergency where direct pressure will not stop bleeding. If a tourniquet is in place it should be left there until facilities for stopping bleeding surgically are available, i.e. in an operating theatre.

5. Indriven clothes and equipment are dangerous sources of infection and all attempts should be made to remove them at operation.

6. The treatment of the wound is in two stages.

(a) *Wound excision.* Skin is very valuable and only damaged skin is excised. A longitudinal incision is made to allow exposure. All damaged fat and fascia are removed and the fascia is opened widely to allow decompression of the underlying muscle. All dead muscle is excised until healthy, bleeding, contracting muscle is seen. The tract is fully explored and all foreign material, especially indriven clothing, is removed. Haemostasis is secured and the wound is left open to drain. A roll of gauze is lightly laid into the wound. The skin is not sewn up. The wound is then encased in wool and dressings and is often fixed in a Plaster of Paris mould. If it is a shoulder wound then a thoraco-brachial plaster splint is applied. A leg wound in a Thomas splint has this converted to a Tobruk splint (a Thomas splint encased in Plaster of Paris). This enables the patient to be moved for the second stage of the operation at the base hospital.

(b) *Delayed Primary Suture.* This is carried out as a second stage operation in the base hospital three to five days after the initial wound excision. The wound by this time is clean and the swelling of the tissues from the blast injury will have subsided, allowing closure. If closure is not possible at this stage and the wound is clean, a split skin graft can be applied to close the defect.

7. Abdominal casualties should be retained at the Casualty Clearing Station for at least seven to ten days and should not be evacuated before this period. This fact was established many years ago, but no proof or explanation for this appears to be recorded.

All other cases travel well and can be moved for the second stage of the operation within twenty four hours of the first operation. They can be moved by road or by air.

7. CONCLUSION

One of the new features of evacuation by helicopter is that patients who would normally have died at the Regimental Aid Post or en route by conventional road transport, may survive the short hop by helicopter. This may mean salvage of life which would previously have been lost, but it may also mean the arrival at the surgeon of cases, alive, but too far gone to survive. The surgeon faces the difficult decision with such cases, as he may spend too much of his valuable time on one hopeless patient when he could be doing work on cases which will survive with treatment. The decision is clear but difficult.

Helicopter evacuation is a great advance both for the wounded man and for the Medical Officers who come to depend upon them. Some concepts in casualty handling require second thoughts when considering their use, and time and experience alone can provide the best answers.

DISCUSSION

The session chairman proposed that discussion on this paper should be deferred until after the next presentation, that by Wg Cdr Brown, RAF.

THE RECEPTION OF AIR EVACUATED CASUALTIES

by

Wg Cdr R.P. Brown, FRCS, RAF

RAF Hospital, Ely, Cambs., UK

RESUME

L'auteur rend compte ici du fruit de ses expériences en tant que Chirurgien Consultant dans les Hôpitaux Militaires d'Aden où blessés civils et militaires furent traités au cours des opérations de Radfan en 1964 et des activités terroristes des mois suivants dans la Fédération d'Arabie du Sud.

En ce qui concerne le traitement des blessures causées par des missiles, il rappellera les principes de base de la réanimation et des soins à donner aux plaies, et soulignera la valeur des transfusions et des sutures primaires différées.

Il exposera les avantages et les problèmes de l'évacuation aérienne, ainsi que leur rapport avec les divers besoins du patient et du chirurgien.

THE RECEPTION OF AIR EVACUATED CASUALTIES

Wg Cdr R.P. Brown, FRCS, RAF

It is with great pleasure that I have the honour to offer to this Symposium my own comments on casualty evacuation by helicopter, speaking as a general surgeon responsible for their further hospital care, and in many cases for their initial treatment also. Much of my material must overlap with that already presented by my medical colleagues in the Army and the Royal Navy. The co-operation between these three arms of the British Armed Forces was, and is, very close in South Arabia whether working at the same jobs or performing different parts of the same task.

Aden and its hinterland has always been one of the world's trouble spots. To endemic tribal rivalry and sporadic warfare have been added national disharmonies. Such a combination of circumstances led to the unrest of tribes in the Radfan area, in 1964, which has continued with the Nationalist terrorism. This area of mountains and rocky valleys lies about 50 miles North and East of Aden and is approached via a single tarmaced road, which at that time was not complete. Good communications are thus extremely difficult and by narrow tracks only, totally unsuitable for wheeled transport upon which the Army generally relies for support and supply. For this reason, ground campaigns in the past have been impossible and the Royal Air Force has policed the area from the air.

However, the advent of the helicopter has given the Army mobility. It is in its role as an air ambulance that we are concerned in this session. Air transport of casualties was well established by the end of World War II using conventional aircraft. 22,000 cases were flown from Normandy to the United Kingdom in the 3 months after D-Day for hospital treatment. After collection by road in France they arrived at airfields in Wiltshire and were moved by road again to adjacent service hospitals or by rail for wider dispersal. In these circumstances the cases received at Hosptials in UK should not have required urgent resuscitation (since they should not have been loaded in the first instance). Severe sucking chest wounds and patients who had had exploratory operations fo the abdomen were excluded, being retained at more forward surgical centres.

The chain of care was thus stretcher party to Regimental Aid Post, for primary first aid, and thence to an advanced dressing station and to a casualty collecting station which functions as a surgical unit since it is linked with field surgical and transfusion teams. Further moves to base areas are required later. In general the early moves are by ambulance, the later by road, rail or air. The principles underlying this organisation can be stated as bringing medical care to the injured, as far forward as is practicable in the circumstances at the time, principles enunciated by John Hunter and Larrey. The helicopter has altered the emphasis and now it is possible to bring the casualty to the established medical centre - that is, to the base hospital outside the area of immediate hostilities. The distances that are acceptable are measured as before in time and not in miles.

In Aden there are two Service hospitals both staffed by the Royal Air Force, one adjacent to the main air base at Khormaksar, the other about seven miles away. There is also a large, well equipped civilian hospital for local nationals. Helicopters can land close to each of these three hospitals.

The incidents resulting in casualties are sporadic and frequently at dusk or at dawn. All types of missile injury are seen from landmines to small arms fire, and from mortar shelling and grenade attacks on scattered military outposts. At such points there are only a few servicemen and medical care will be the responsibility of an orderly, and he or comrades will carry out first aid measures and seek assistance. A helicopter will be dispatched on the receipt of a radio message requesting medical help and generally a medical officer will accompany it. The machines used are the small Scout helicopters, the larger Wessex and the twin-rotor Belvedere, and occasionally a conventional aircraft, the Twin Pioneer.

The points I wish to emphasise are that casualties are picked up, usually at the site of an incident, with the minimum of delay, if still under fire, after minimum first aid. They may not have been seen by any medical officer. Their condition on arrival at our hospitals depends entirely upon the nature of their injuries and the time lag since the moment of injury, taken in conjunction with the first aid measures instituted in the short time available.

The essence of the problem lies in the speed at which evacuation is possible. In civilian road accidents the aim is to call the ambulance and race the patient to hospital. In military operations this ideal is not always possible although it could be organised at the expense of other flying commitments. If it cannot be guaranteed, then forward medical services are still necessary to save life and to prevent the onset of shock by starting measures of resuscitation in the field. The wounded travel well if despatched shortly after injury and a rapid flight brings them to hospital. But once a delay has occurred then a pause to set up an intravenous infusion is time well spent, and a stop at a forward aid post is preferable to immediate evacuation.

The flight duration to Aden is about 35 minutes. I believe it to be true that no patient is unfit to travel by helicopter, just as no casualty is unfit to be placed on a stretcher. Moving a patient requires care, and injuries (for example a broken spine) must not be aggravated. A casualty cannot be left where he is, without care at all.

First aid measures to save life or to avoid losing a life unnecessarily must be taught to all ranks. There are only a few situations where the care received affects the eventual outcome, but these *must* take precedence over all other aspects of treatment.

1. *Controlling major haemorrhage.* Torrential bleeding internally in chest or abdomen may well be fatal. No first aid measure is effective and immediate transfer to hospital gives the only hope of survival, with early surgery.

For bleeding from soft tissue injuries of the limb, direct pressure at the site, using the field dressing tied firmly in place, is preferable, to the use of a tourniquet. If blood soaks through a new pad is added to the outside of the original one. If conditions permit, the accurate placing of a haemostat on the vessel may help but some form of sterile swabbing and good lighting is required to avoid injury to adjacent structures.

The same applies to wound-packing with through and through sutures, but this is preferable to the use of the tourniquet and may well make the flight to hospital less hazardous.

I doubt if there is any place for the tourniquet except in the first moments after injury whilst dressings are being applied, or to afford firm pressure over a field dressings. Certainly to transport a casualty for any time with one in position is to imperil the limb. Where I have admitted casualties with tourniquets in place, releasing them has not resulted in catastrophic haemorrhage. There is little opportunity to care for a patient in a helicopter and there is an argument there for placing the tourniquet in position to be tightened in an emergency, but other measures are preferable to control bleeding before departure. In the dangerous injuries at the root of the limb, tourniquets cannot be used anyway.

2. *The sucking chest wound.* This must be closed at the earliest possible moment. Air entry into the open chest wall is prevented by fixing a field dressing in place at once, and leaving it undisturbed. These patients travel well once the leakage is controlled and respond well to early surgery, provided major structure in the chest are not injured.

3. *The maintenance of a free airway.* This is possibly the major hazard to the life of a casualty suddenly lifted and transferred as an emergency. Blood and mucus in the throat, vomit or foreign bodies such as dentures, or the tongue falling back will suffocate the unconscious patient who cannot clear his own airway by coughing even if the original wound bleeding is relatively trivial (eg a facial fracture with nose bleed and concussion). The obstruction must be cleared before loading and the patient laid prone, the face projecting beyond the canvas of the stretcher and the forehead supported by bandages between the handles. Thus blood and secretions can drain away and the tongue does not fall back. In the obstructed patient death can follow within minutes, even at the door of the hospital.

4. *Measures for resuscitation.* Obviously some form of medical training is necessary to set up an intravenous transfusion, but I do not believe that it should always wait upon the arrival of a medical officer. A medical orderly can be trained for this duty. In Aden we used reconstituted plasma rather than dextran to avoid interfering with subsequent blood grouping and cross matching. Using small pools of plasma in drying, the risk of transmitting jaundice is much less, and acceptable.

The use of blood in the field was advised against. The time delay between injury and admission to hosptial was not such that anaemia was a major hazard provided a plasma expander was used. A medical officer was not always available and mistakes in grouping and cross-matching could not be excluded, offering a further hazard to life with little gain.

However there is no doubt in my mind that patients travel better and arrive in a more satisfactory condition and are ready for operation earlier if plasma is given as early as possible after injury and continued during evacuation. Normal saline is a poor alternative and its effect short-lived.

It is not always possible to administer to patients during flight, and if they travel in a pannier attached to the skids of the Scout helicopter it is impossible. For the future I believe that this factor should be taken into account in alloting helicopters to the task of air evacuation.

Oral fluids are contraindicated in all cases who are expected to require surgery and anaesthesia. Sucking ice or a moist rag may provide comfort however. In hot climates the relative dehydration of those exerting themselves aggravates the physiological stresses of injury and makes fluid replacement even more urgent.

I do not need to dwell on the other measures taken in the field to help the wounded. Fractures are splinted, normally only minimal fixation is required such as a sandbag or a wire splint to prevent accidental movement. Tetanus toxoid, penicillin and morphine are given to all cases almost routinely and I have no experience of tetanus infection. Burns are covered: The Army has provided sterile-packed polyurethane foam sheets for fixing as transport dressings. The difficulty lies in having them available at the point of injury since the Battalion aid post is generally by-passed en route to hospital. The cleanest material available should be utilized as a temporary cover to protect from the dust and dirt thrown up by the rotor blades of the helicopter. Burns travel well before the onset of shock, and an early start to resuscitation should be made, again giving intravenous plasma.

Documentation should be very simple if casualties are being admitted virtually direct for definitive care, since a further move is unlikely from the base hospital until they are convalescent. Their own identity card records their personal details and the field injury card need only indicate time and cause and severity of injury and whether morphine or other drugs have been given. In general, in the circumstances we worked in in Aden we seldom needed the details this document provides.

The conditions fo the flight itself seems to have little effect on the state of the patient on arrival at hospital. I have already commented that in-flight care may have to be minimal but if the flight duration is only 20 to 30 minutes, this must be accepted. However pre-flight preparation or an intermediate stop at a Battalion aid post may be preferable to the longer dash straight to hospital (if the patient's condition is serious). The time from injury is probably the determining factor on the need for resuscitation measures. If this has already exceed 4 hours, a slightly longer delay to start a transfusion is better than immediate evacuation.

The knowledge that proper hospital care with all the facilities of a civilised community are available a few minutes away by air is a major help for morale and there is no doubt that the helicopter is the ideal ambulance for war casualties and that medical care should be planned around its use. In World War II the use of supply aircraft for air evacuation of casualties was generally subordinate to their other roles as freight or transport planes. The air evacuation of casualties is a vital factor in any battle and not a luxury. It is an essential part of the planning task, and in my view, aircraft or helicopters should be allocated for this task alone as air ambulance squadrons under the control of the Medical Staff. This should bring an end to conflict between Field Commanders and the Medical Branch in assessing priorities. The advent of the small support helicopter such as the Scout or the Wessex makes this feasible, whereas tying a Dakota to this work was unacceptable.

If a base hosptial is to receive acute casualties, various planning and design points must be considered. The helicopter landing area should be close enough to avoid the use of ancillary transport, but at the same time, the ward areas should be protected from noise and dust. The hospital reception area must be large enough to permit the resuscitation, sorting and emergency care of multiple acute casualties, and with all the necessary equipment. In a permanent establishment this can be diverse and complex.

Consideration should be given to the design of stretchers: they should be suitable for air transport and stowage, designed to fit in aircraft bays but also suitable for hospital use to avoid repeatedly moving the patient, in particular they should be suitable for use in a Radiographic Unit and not be opaque to X-rays.

The advantage of working at fixed bases are many. The standard of care that is possible is higher and at the same time it is economical of medical and technical man-power.

It is not my purpose to discuss the later surgical treatment of war casualties at any length but to emphasise that all our experience has shown that wounded excision followed by delayed primary closure 4 - 5 days later is as effective today as it was in 1945 and in 1918. The major advances in surgery over the last 25 years such as operations on major vessels, the use of the artificial kidney, the care of burns in the acute shock phase, chest and neuro-surgery and so on - all have been dependent upon expert, accurate ancillary services in laboratories, radiological departments and good anaesthesia. If we are to offer these advances to those injured in war, then early efficient routine evacuation to sophisticated fixed medical centres is essential. The helicopter has made this possible.

DISCUSSION

Wg Cdr Eley, commenting on the remarks about blood grouping and cross matching, asked why it was not general for service personnel to carry their relevant data on identity discs. **Wg Cdr Brown** replied that in all services of which he was aware the risk of error in the initial grouping or subsequent incompatibility for other reasons was of such magnitude that grouping and matching after injury could not be dispensed with. **Air Cdre Yerbury** stated that improved techniques were being tried and that blood group data were to be recorded on identity cards in the near future, although he agreed that subsequent field tests should be carried out whenever possible before blood was administered. **Wg Cdr Eley** disliked the idea of data recording on the identity card and felt it essential to record such information on a disc or plaque worn round the neck or on the wrist. **Capt Buckley** commented that US Army personnel have blood group and Rh type recorded on identity tags. **Capt Mattox** stated that in spite of such data, it was practice in Vietnam to use only group O, low Rh titre blood for immediate transfusion if cross-matching was not possible. **Wg Cdr Brown** agreed with this practice, which had been used in Aden.

Col Thierschmann expressed anxiety at any suggestion that the use of the field medical record card might be dispensed with in conditions where immediate casualty evacuation to base areas was possible. In particular, this document was invaluable where casualties of one nationality were transferred to the care of medical personnel from another nationality. **Col Neel** agreed that a modest amount of information was essential. The first medical orderly to attend the casualty should initiate the card, but in practice this was often deferred until the case arrived at a hosptial.

Brig Gen Lauschner commented on the number of types of stretcher or litter in use, and **Col Cody** added that at Anglo/US bilateral trials which he had just attended incompatibility between British stretchers and US helicopters was a serious problem.

Considerable debate on the shortcomings of current stretchers followed, and it became clear that much work was needed before such incompatibilities could be overcome. **Col Neel** pointed out that there could readily arise in field conditions serious logistic problems with shortages of stretchers either at base areas or in forward units. **Wg Cdr Brown** urged development of a stretcher of stacking-basket type, cheap, disposable perhaps and compatible with the concept of minimum handling of the patient. To this end such a device should be acceptable in all stowages, translucent to X-rays, suitable for prone or supine nursing etc.

Wg Cdr Fryer asked about experience of the values of external carriage of casualties in 'panniers'. **Col Neel** stated that they would be unacceptable to the US Army who based their casualty handling procedures on a mandatory requirement for en route access.

UN INHALATEUR PORTATIF D'OXYGENE

par

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SUMMARY

A portable apparatus for the supply of high pressure oxygen is described. It is made up of parts normally used in aircraft.

UN INHALATEUR PORTATIF D'OXYGENE

Lt.Col.A.Landrain, SAF, MC

Les hélicoptères de la Force Aérienne Belge ont, entre autres missions, celle de porter secours à tout accidenté grave se trouvant à un endroit difficilement accessible, principalement en mer ou en montagne.

Il est important que l'équipe de secours ait à sa disposition, outre une trousse de soins urgents, un inhalateur d'oxygène qui permette un trai ment réanimateur.

Un système particulièrement intéressant a été conçu et mis au point à la Force Aérienne Belge. Il s'agit d'une caisse métallique contenant une bouteille d'oxygène comprimé à 450 psi, un régulateur d'avion D2 ou MK17, un masque classique. Dans la chenille du masque est insérée une valve de Burns destinée à supprimer l'arrivée d'oxygène au masque pendant l'expiration. Le poids total de l'appareil est de 10 Kgm (Fig.1 et 2).

Sur la face supérieure nous trouvons le régulateur, la vanne d'ouverture, le manomètre indiquant la pression existant dans la bouteille, l'indicateur de débit, le bouton de surpression.

Le levier de dilution ferme l'entrée d'air ambiant. D'autre côté se trouve la vanne de remplissage et un joint permettant le remplissage à partir d'une source d'oxygène à haute pression.

Dans la petite cassette centrale se trouve le masque classique et sa chenille, dans laquelle a été incorporée une valve de Burns destinée à supprimer toute arrivée d'oxygène pendant l'expiration.

La source d'oxygène est une bouteille de 8 litres supportant une pression de 450 psi. Une valve de sécurité empêche toute surcharge.

Toutes ces pièces, à l'exception de la valve de Burns, sont d'origine militaire. Le montage de l'appareil ne présente aucune difficulté et peut être réalisé dans un atelier de maintenance d'unité.

La manoeuvre de l'appareil est simple et peut être exécutée correctement par toute personne, même peu initiée.

La surpression donnée par le régulateur est d'environ 15 cent. d'eau; l'appareil fonctionne automatiquement si le patient ne respire pas. La valve de Burns laisse passer l'oxygène vers le masque aussi longtemps que la pression de l'air alvéolaire n'égale pas celle débitée par le régulateur; au moment de l'égalisation de ces

pressions, le déplacement d'une membrane coupe l'arrivée d'oxygène; l'élasticité thoracique provoque une expiration qui ouvre la soupape d'expiration du masque. L'expiration terminée et la pression pulmonaire étant tombée, la valve va débiter de l'oxygène en surpression, créant ainsi un rythme respiratoire artificiel. La fréquence de ce rythme est fonction de la capacité pulmonaire et de la surpression. L'appareil est conçu pour un rythme respiratoire d'environ 15 mouvements par minute.

Il va de soi que les voies aériennes doivent être libres sinon une aspiration préalable s'impose. La valve de Burns émet un bruit rythmé très rapide en cas d'obstruction des voies respiratoires. L'espace mort du masque maintient un taux convenable d'anhydride carbonique pour maintenir une excitation suffisante du centre respiratoire. La réserve d'oxygène est de vingt minutes, au débit maximum.

L'appareil est léger, simple à manier, aisé à recharger, sa sécurité est totale. La construction et l'entretien sont simples et sont dans les possibilités des bases aériennes. Toutes les unités importantes de la Force Aérienne Belge en sont dotées.

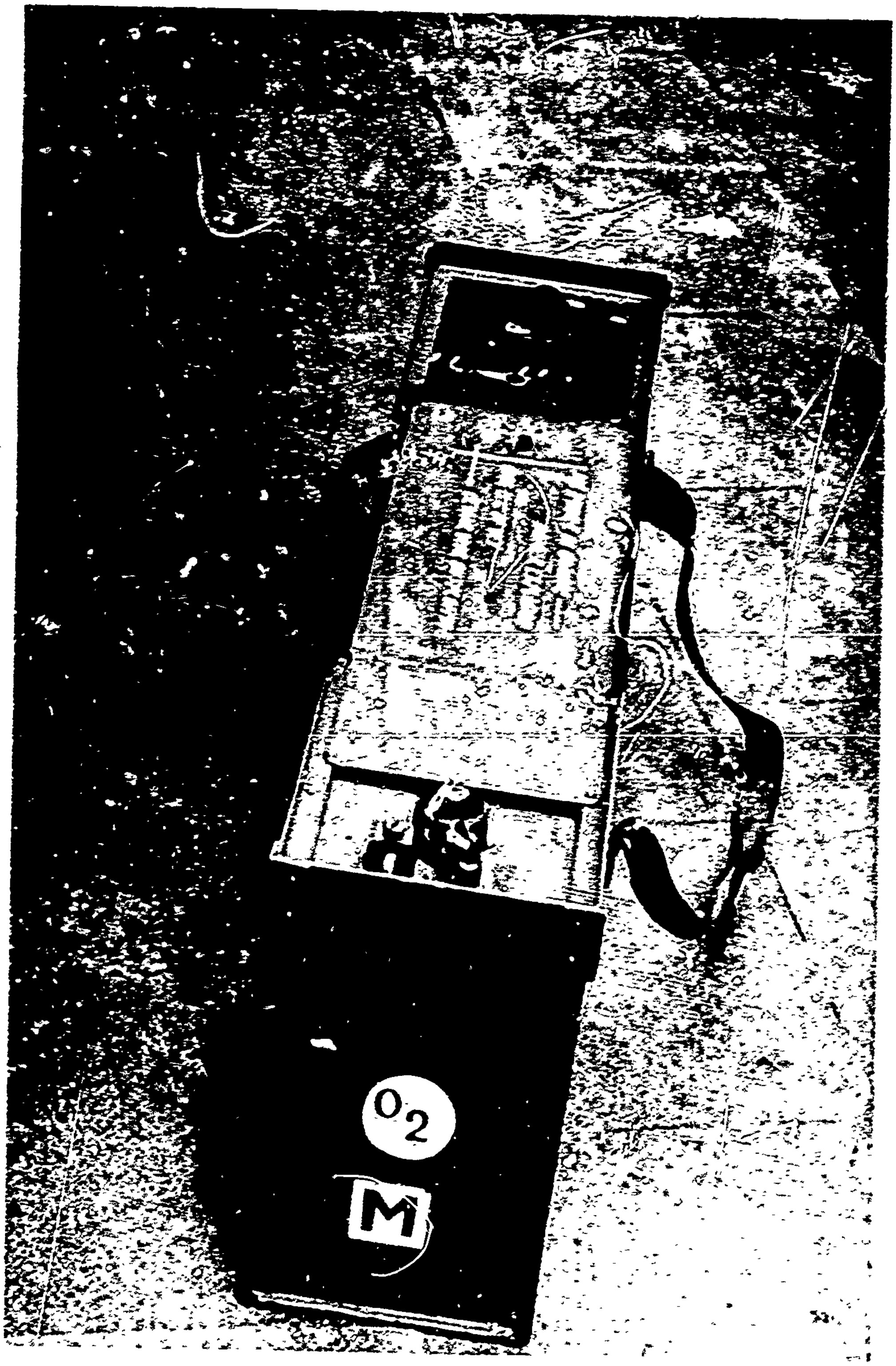
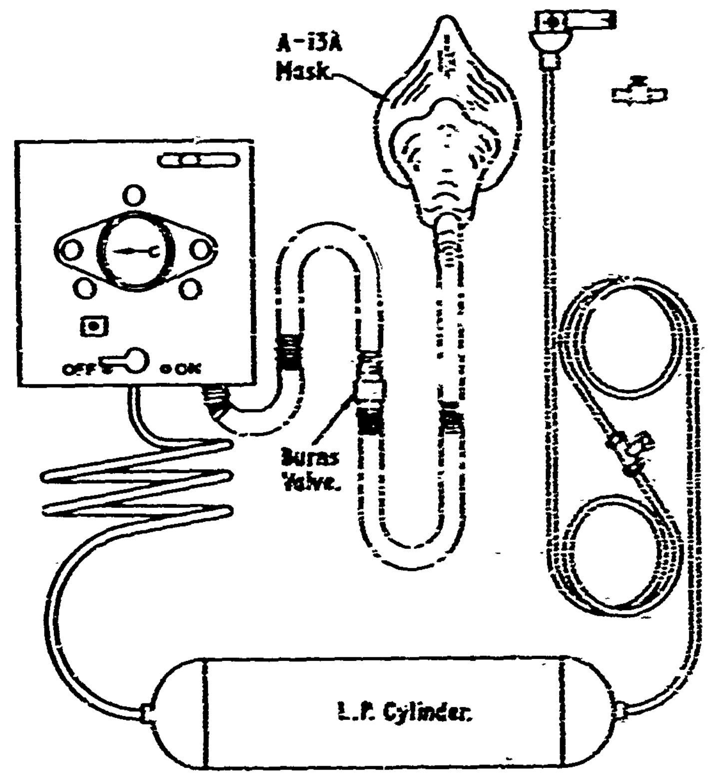
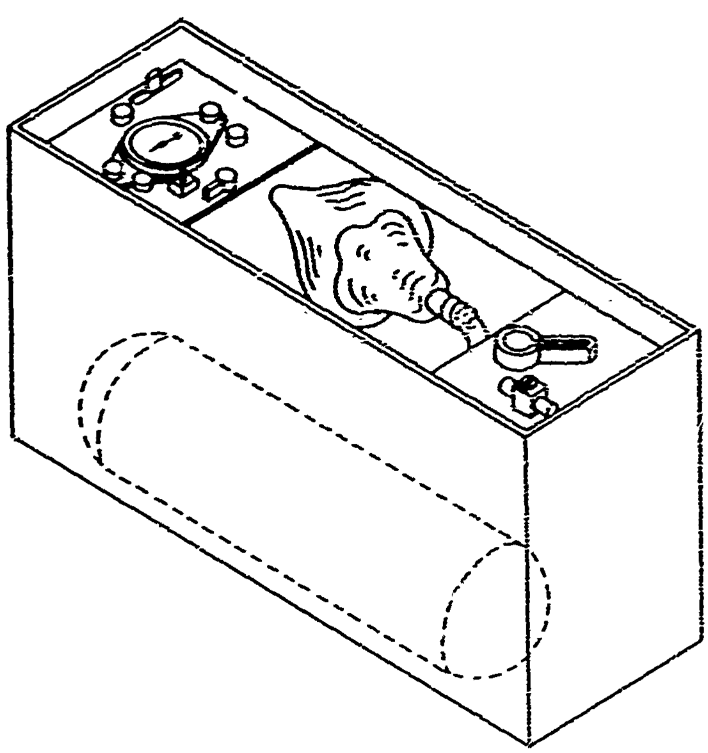


Fig. 1 L'inhalateur portatif d'oxygène





Mask	Masque
OFF	Formé
ON	Ouvert
Burns Valve	Valve de Burns
L.P. Cylinder	Bouteille B.P.

Fig. 2 Schéma de l' inhalateur portatif d' oxygène

HELICOPTER CASUALTY EVACUATION

by

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RESUME

L'organisation, et le contrôle opérationnel des services d'évacuation par hélicoptère sont discutés, et des examples de problèmes rencontrés sont tirés de l'expérience en Sud Arabie et Bornéo.

Le rôle vital de l'infirmier de compagnie dans les premiers soins des malades dans ces conditions, est souligné et l'organisation des services de soins chirurgicaux est indiquée.

HELICOPTER CASUALTY EVACUATION

Lt Col A.M.Ferrie, RAMC

Even before the end of the second world war air evacuation was being increasingly used to get the wounded well clear of the battle zone. Experience since 1945 has clearly demonstrated that air evacuation is the method of choice in casualty transportation and can be used in the battle zone as well as in the more rearward areas.

The increased speed of air evacuation over any other form of casualty transportation allows the serious casualty to be taken rapidly to the surgeon and, as a result, has saved many lives.

The increased use of the helicopter by the fighting troops for deployment has meant that they are no longer dependent on roads for movement or supply and, as a result, the helicopter in these cases is the only method of casualty evacuation available.

The mobility of modern warfare is depending more on air movement and less on motor transportation. If casualty evacuation is to be successful, it must conform and utilise the helicopter. The increased cost and overheads of the helicopter can be to some extent offset by:-

Reduction in motor ambulances needed, because of the increased speed of the helicopter.

Reduction in medical manpower needed, as the helicopter to a large extent replaces the stretcher bearer and eliminates most of the intervening medical posts between the infantry and the surgeon which were previously necessitated by road casualty evacuation.

AVAILABILITY OF AIRCRAFT

The British Brigade has at the present time few helicopters within its organisation. It has a Brigade Flight of six helicopters, each of which can carry two stretcher cases in external pods and one stretcher internally. In addition each Battalion or Artillery Regiment within the Brigade has its own flight of three light helicopters. These helicopters can carry two stretcher cases in external panniers.

Where the operational situation so dictates larger helicopters are made available to support the Brigade. These aircraft are supplied either by the Royal Air Force or by the Royal Navy.

CONTROL OF CASUALTY EVACUATION

With this mixture of helicopters both in type, size, and source of supply, casualty evacuation is controlled centrally from an Air Operations Centre at Brigade Headquarters. Notification of casualties is made by Battalions to Brigade Headquarters who are responsible for tasking aircraft for casualty evacuation. This may be done in three ways:-

(a) By sending a helicopter forward from the rear Brigade area to collect the casualty.

(b) When the brigade area is large, by tasking a helicopter which is already deployed in the forward area.

(c) By diverting a helicopter which is airborne on another task.

When considerable distances are involved all three systems may be used.

Where larger formations are involved, such as a Division, this in turn has an Air Operations Centre for tasking the aircraft under its direct control.

This system meets most of the criteria for efficient utilisation of the helicopter effort.

(a) The tasking of aircraft is controlled from the army headquarters which is directing the battle.

(b) The highest priority tasks can receive urgent helicopter backing to the detriment of less urgent tasks.

The fault from the doctor's point of view however, is that he has only indirect control over the transportation of casualties and therefore of medical evacuation. In addition, the time when serious casualties occur is usually the time when urgent troop movement or resupply are required by the forward troops.

RADFAN AND BORNEO EXPERIENCE

The two most recent operations or police actions in which the British Army has been involved were the Radfan (in the Aden territories) and Borneo. In both cases much of the troop movement and supply was by air, and casualty evacuation had of necessity to be by air also.

RADFAN

In the Radfan the main area of operations was within 50 - 80 miles of Aden and consisted of desert and mountainous terrain. There were no roads suitable for ambulance cars.

Troops deployed basically as battalions to control an area by occupying strong points. Having cleared one area they moved on to a new area, usually by night. Sometimes the infantry moved on foot, sometimes they were carried by helicopter. The battalions were reasonably concentrated with outlying pickets or companies. Behind the battalions was a main base about 10 miles to the rear which had an airstrip for fixed wing aircraft.

Helicopters, by using the lie of the land and such rock cover as was available, were able to provide close support to the battalions. Helicopter landing zones were no problem except occasionally in mountainous terrain, but even here they were able to load at the hover.

Due to lack of cover, casualties usually had to be carried back a few hundred yards out of the direct line of fire before they were loaded onto a helicopter. They were then flown to the main base where a medical section of the Field Ambulance was situated. The further 50 miles to hospital in Aden was normally flown by fixed wing aircraft.

BORNEO

In Borneo the situation was more difficult. The Medical Services were required to provide medical cover to troops of approximately Divisional strength in periodic contact with the enemy, along a jungle frontier of nearly 1000 miles.

The infantry battalions were deployed in company or platoon positions. These positions were static locations, well dug in for protection if attacked, and providing bases for patrolling the border area. Some were in contact with the rear by road, but the majority had no road communications, and were supplied and reinforced by air.

There were only two permanent surgical centres to cover this front. A soldier, wounded in the forward areas, might therefore have to travel between 30 and 300 miles to reach one of the two surgical centres. When the distance of evacuation was short he was flown direct from the place of wounding to the surgical centre; when the distance was longer he was first flown to the Battalion Aid Post where he received initial treatment from the Medical Officer before continuing his evacuation to the surgical centre.

Some battalion areas were small while others were over 1000 square miles in extent. With distances great and roads few and far between the medical officer usually had to visit his forward companies by air. In the early stages in Borneo, with a relative shortage of helicopters, the Medical Officer had difficulty in making frequent visits to his forward companies. This left much of the responsibility for the day to day care of the sick on the Company Medical Orderly.

When the battalion was relatively near one of the surgical centres the wounded were normally flown direct from place of wounding to the surgical centre. This situation again left the Medical Officer sitting to one side, and threw most of the responsibility on the Company Medical Orderly. It was only in the later stages with the introduction of the unit light helicopter, that the battalion medical officer really started to have full supervision of his sick and wounded, travelling round his company positions regularly to see the sick, and going forward to attend the wounded after an enemy attack.

THE COMPANY MEDICAL ORDERLY

The use of the helicopter has thrown increased responsibility on the Company Medical Orderly especially in situations such as Borneo.

The Company Medical Orderlies were either battalion personnel, trained in medical duties, or Medical Corps personnel attached to the battalion. They ran the company or platoon aid post, and were responsible for the day to day treatment of the sick between visits of the Medical Officer. They accompanied patrols in the border area and were responsible for the initial treatment of the wounded. Unless a Medical Officer could get forward, the decision on whether a sick man required evacuation rested on them, with such advice as could be given by radio. The job called for a soldier who was fit enough to go on patrol, had a knowledge of infantry tactics, had good medical knowledge, had initiative, and had self confidence. It was not easy to find sufficient men of this calibre who could be made available for these duties.

EVACUATION FROM FORWARD AREAS

Each forward position had a helicopter landing pad and evacuation of sick or wounded from such positions presented little difficulty. Evacuating casualties from patrols which were mainly operating in primary jungle usually involved first cutting a helicopter landing zone before the casualty could be lifted out. As operations progressed an increasing number of landing zones were cut in the border areas and patrols or ambushes were planned to allow for an easy withdrawal to a landing zone should casualties occur. Alternatively a new landing zone was cut early in the operation. This procedure increased the speed of evacuation and allowed patrols to quickly disencumber themselves of casualties.

Other factors which produced delays in casualty evacuation were:-

Weather

An afternoon build up of cloud on the hills and an early morning mist in the valleys were routine in the mountainous country. Many forward positions were on high ground and got clouded in. This slowed, but did not prevent casualty evacuation.

Pin Pointing Patrols

It was not always possible for a patrol in primary jungle to give their exact position. Radio beacons were not carried as a routine, and short delays did occur in finding patrols.

In the British Army it has always been policy to try and get the casualty to the surgeon within six hours of wounding. With the circumstances pertaining in Borneo this was not always possible even with the aid of helicopters.

SURGICAL CENTRES

The supporting medical unit in the British Army is the Field Ambulance. It is designed to form an Advanced Dressing Station which, when a Field Surgical Team is attached can form a surgical centre. In addition it can form three medical sections, each with a Medical Officer, which can be deployed forward in support of the infantry battalions. While one medical section was used in the Radfan, in Borneo they were split up and the individuals used as Company Medical Orderlies.

Both surgical centres in Borneo were staffed by Field Ambulance personnel, one with a Field Surgical Team attached. They were situated in civil hospitals and were in fact military wings of these hospitals.

A close liaison was maintained with Brigade Headquarters and whenever casualties occurred in the forward area the surgical centre was informed. Details of the type of casualty and the expected time of arrival were passed on by the Air Operations Room before the casualty arrived by helicopter, and the surgical centre as a result was fully prepared.

Casualty rates in both Borneo and the Radfan were low but even with limited helicopter resources we were able to cope. We were not extended. Had a major incursion happened in Borneo we would have been faced with the problem; troop movement or the evacuation of casualties. Fortunately we did not have to make this decision.

At the start of the first world war it was felt by some that ambulances were unnecessary. Trucks carrying forward stores and ammunition could bring back casualties. It was found that this system did not entirely work. The same argument has been used about helicopters, the helicopter going forward with troops and stores can bring back casualties. This again is not the complete answer and it is to be hoped that in the not too distant future, the British Army like others may have a few medical helicopters.

USE OF A COMPUTER SIMULATION TO EVALUATE MEDICAL HELICOPTER EVACUATION SYSTEMS

by

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RESUME

Afin d'avoir un aperçu du nombre d'ambulances aériennes et terrestres nécessaire au soutien d'une division d'infanterie on a utilisé un modèle de simulation par ordinateur conçu pour évaluer l'efficacité relative d'un système d'appui sanitaire de division. Ce dispositif fait partie d'une série de trois modèles de simulation capables d'évaluer un système d'appui sanitaire depuis le lieu de recueil d'un blessé jusqu'au traitement et à l'exéat d'un patient hospitalisé. Les trois modèles sont conçus pour fonctionner sur un ordinateur IBM 7090 ou 7094, comportant une mémoire interne de 32,000 mots et 8 circuits de bandes magnétiques. Pour procéder à cette évaluation, on s'est efforcé de déterminer le dosage adéquat des moyens d'évacuation aériens et terrestres nécessaires au soutien d'une division d'infanterie engagée, en Europe Occidentale, dans une guerre terrestre classique généralisée et de grande envergure. On a procédé à une série de 22 opérations sur simulateur en utilisant diverses combinaisons de possibilités d'évacuation terrestres et aériennes. Chaque opération fournit des données sur les facteurs de performance pour la combinaison de moyens terrestres et aériens étudiée. Les facteurs utilisés pour évaluer chaque système de soutien étaient les suivants: (1) délais d'évacuation, dus à l'absence de moyens d'évacuation disponibles, (2) temps moyen écoulé entre le moment de la blessure et l'arrivée du patient dans une installation médicale de l'arrière, (3) temps morts des moyens d'évacuation et (4) chargement moyen de patients par voyage. On n'a pas essayé, au cours de ces opérations de simulation, d'évaluer l'influence des conditions météorologiques ou d'une action ennemie sur les systèmes d'évacuation étudiés.

USE OF A COMPUTER SIMULATION TO EVALUATE MEDICAL HELICOPTER EVACUATION SYSTEMS

Major J.E. Bizer

1. INTRODUCTION

The US Army Combat Developments Command Medical Service Agency, located at Fort Sam Houston, San Antonio, Texas, has the mission to determine "How the Army Medical Service will be organized, equipped and support the fighting forces". To support this mission, the agency has developed an operations research program designed to permit the evaluation of field army medical support systems either as a whole or in parts.

Initially, as with any operations research effort, valid *input data* must be obtained. To provide this type of data, a study to determine the casualty potential of weapon systems is currently under way. The study will investigate the casualty-producing potential of known weapon systems and assess the combinations of effects that may occur when one or more of the systems are employed.

Once the casualty data are obtained, the next logical step would then be a system capable of performing a thorough evaluation of the impact this casualty load will have on a given medical support organization. This system we have today in a series of *computer simulation models*. I will talk more about one of these models in a moment. The *end result (output)* would then be improved medical doctrine, tables of organization and equipment and the supporting field and technical manuals.

2. COMPUTER SIMULATION TECHNIQUES

Ever since it was determined that computer simulation techniques could be used to analyze the elements associated with field army medical service systems, certain questions have arisen concerning the nature and use of such techniques. The questions most frequently asked are: (1) what is a computer simulation model and what features should it have in order to be a useful tool for systems analysis, (2) why are such models being used in the analysis of staffing requirements, and (3) how are the models to be used in the performance of this analysis?

Anything which assumes the appearance of an operating system can be described as a "simulation model". A type of model in general use today is the computer simulation model in which a general purpose high speed computer is programmed to operate in a manner representative of the way the system itself operates. So that we are all talking the same language, I will define a "simulation model" as "a simplified representation of an operation or process in which only the basic points or the most important features of a typical system under investigation are considered".

A computer simulation model is made up of the following components:

1. A representation of the computer's memory of each of the elements involved in the system to be studied.
2. A set of rules governing the behavior of the individuals within the system.
3. The program by which the given rules are applied to systems elements in order to produce behavior and interactions as they would occur during the actual operation of the system.

Because of the high speed and large memory capacity of modern computers and the ease with which they can be programmed, computer simulation models can in most cases provide a convenient time-saving and relatively inexpensive means of studying the operation of large complex systems and produce estimates of what a system can accomplish. An important advantage of a simulation model is the fact that its structure can be and usually is, much simpler than that of the system it represents. The many factors in a system which have little or no overall effect on its operation can normally be omitted from consideration in the systems model. The question arises of course as to which factors are significant and which are not. This question can often be answered by someone familiar with the systems operation, or by means of a preliminary operational analysis. However, if any question remains concerning a factor's significance, the factor is retained in the model for further evaluation.

The purpose of analyzing any system is to determine whether the system can be modified in some way to improve its effectiveness and/or reduce its cost of operation. The purpose itself implies the existence of alternate ways of organizing and operating the system. Ideally such a model should be so general that most of its specific form and structure in any particular application will be provided rather than by restrictions within the computer program itself.

3. THE PROBLEM TO BE ANALYZED

With this basic background of the agency's operations research program and model definition in mind, I would like now to demonstrate how we approach the problem of: "obtaining an insight into the determination of the proper mix of air/surface ambulance capabilities needed to support an infantry division".

To do this I will first describe the model used in a little more detail, the scenario and evacuation systems studied and criteria used for analysis.

Figure 1 is a brief schematic of the model as used for this evaluation. This model was designed to simulate the medical activity from the rear of the maneuver battalions through delivery of a patient at the front door of a supporting combat zone hospital. Within our series of models, we have one capable of evaluating the medical activity of the maneuver battalion and another which can evaluate the impact varying patient loads have on a hospital system. So in effect with the three models available, we can follow a patient from site of wounding through his discharge at a hospital.

This model can follow approximately 400 patients at one time through the division level treatment facilities and is specially programmed to determine the effectiveness of treatment and evacuation systems. The schematic shown here is a representation of

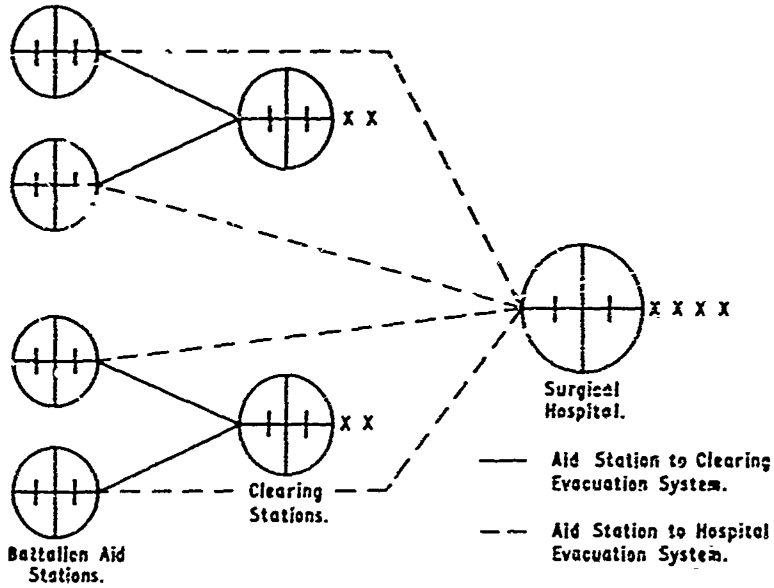

Fig. 1 Schematic of simulation model

how the model was programmed to handle this particular problem. The model is flexible however, since any of the treatment facilities may be by-passed through use of proper input. This gives the planner the ability to simulate the medical support systems for present or any future organizations. You will note on the schematic that we have two distinct evacuation systems outlined. The solid lines show the movement of patients from the rear of the battalion aid stations to the two supporting clearing stations. The broken lines outline the evacuation of patients from the battalion aid stations (BAS) to a supporting surgical hospital. The reason two separate systems are shown is that the model treats these systems as separate entities and their activities are summarized independent of each other. The summary of results shown later in the briefing will describe both of the systems shown on this schematic.

4. THE INPUT DATA

There are approximately 2500 items of input required for each simulation run. These inputs can be grouped into five basic areas as shown in Table I:

TABLE I

General Inputs to Simulation Model

Time Related	*Doctrine*
1. Time Step 2. Length of Daylight 3. Initial Time of Run	1. Unit Relocation Criteria 2. Operations of Evacuation Teams 3. Emergency Evacuation Routine 4. Pick-up of Patients at BAS 5. Treatment and Patient Handling Routines throughout Area

4.1 Time-Related

The Time Step establishes the length of time which the computer assumes has passed before rechecking the entire system. Other general time inputs describe the hours of daylight so that conversions can be made from day to night speeds for vehicle and personnel movement. The initial time of day is used to orientate the computer in determining when to convert from day to night speeds.

"Doctrine" inputs dictate how the model will operate for the evaluation being performed.

4.2 Descriptive

TABLE II

General Input Data (Continued)

Descriptive Information
1. Evacuation Team Loading Points 2. Description of Evacuation Network 3. Description of Communication System 4. Unit Organization and Equipment

The data shown in Table II outline the various routines operating within the doctrine established.

4.3 Patient Data

TABLE III

General Input Data (Continued)

Patient Data
1. Frequency of Occurrence 2. Transportation Needs 3. Route Through System 4. Treatment Priorities and Personnel 5. Survival Probability 6. Disposition of Patients

The majority of inputs are entered here. These inputs (Table III) support the 75 different types of patients which can currently be handled by the model. As a patient reaches each level of treatment, specific information is required. For

instance, the *frequency of occurrence* refers to the number of times one of the 75 types of patients can be expected to occur. The *transportation needs* indicate whether a patient is ambulatory or litter and if a special type of evacuation vehicle is required. *The route through the system* and *treatment priorities* determine where treatment will be received and how quickly treatment is required and by whom.

As a patient reaches a clearing station or a surgical hospital, his survivability increases and new treaters are available. Therefore, new curves, new treaters and new treatment times must be available to the simulation to accurately describe the patient's impact as he passes through the system and finally where will the patient go once treatment has been completed.

4.4 Vehicle Classes

Inputs associated with the types of evacuation vehicles being simulated are shown in Table IV:

TABLE IV

General Input Data (Concluded)

Vehicle Classes
1. Air or Surface 2. Speeds (day and night) 3. Capacity 4. Breakdown Probability

5. THE SCENARIO

To perform an analysis and to provide the necessary inputs on the evacuation system within an infantry division, a scenario describing a division in an attack was obtained from the Medical Field Service School at Fort Sam Houston, Texas and adopted to the simulation model.

The scenario, shown diagrammatically in Figure 2 is briefly as follows:

The 20th Infantry Division is engaged in a large scale land mass conventional war. The division objective is to secure a crossing of a river approximately 10 kilometers east of its present position. It is the Fall of the year; the climate is moderate; the area is farm land, rolling, with small trees; the road network is fair. Dawn occurs at six o'clock and there are twelve hours of daylight per day. At 0600, the morning of the first day, the division begins an attack with two brigades abreast on an enemy position along a hill mass approximately 1000 meters to the division's front. Heavy resistance is encountered; however, by 1400 hours the initial resistance is overcome. The division moves slowly against a stubborn enemy for the next four hours and by 1800 hours the objectives have been fully secured. In this initial 12 hours, 240 patients were placed in the

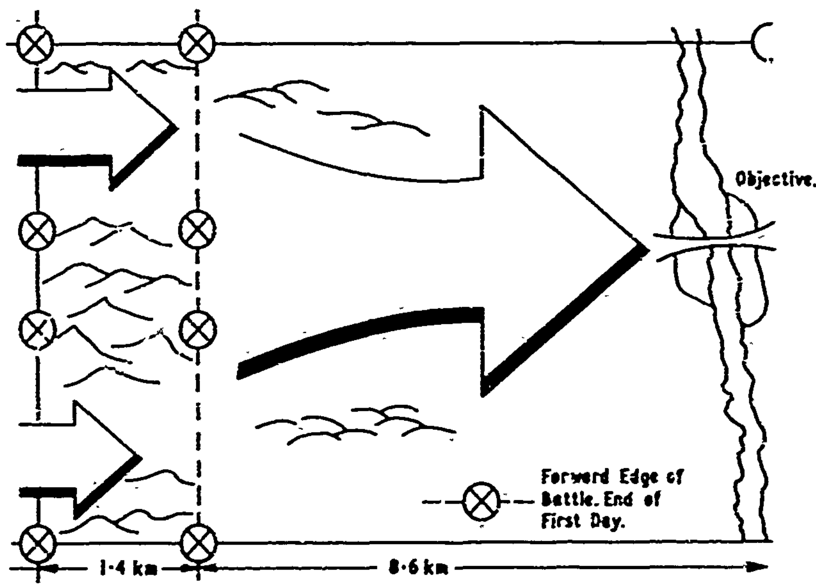

Fig. 2 The scenario

system with the heaviest influx being 34 per hour between 0600 and 1000 hours. The division remains static during the next twelve hours of darkness preparing for the attack in the morning.

Day 2 finds the division attacking a weakened enemy who has withdrawn 1600 meters back from the division line. By ten o'clock the initial resistance has been overcome and the division advances rapidly. By nightfall the division has reached the west bank of the river and is preparing to secure the river crossing the next morning. The patient load in the 2nd day corresponds to the intensity of combat with the heaviest load of 116 patients entering the system the first 6 hours.

6. THE EVALUATION

The evaluation of the division medical service evacuation system consisted of two series, totalling twenty-two computer simulation runs.

The first series simulated the division evacuation system using 18 different air/surface combinations ranging from 3 to 15 helicopters and 8 to 40 ground ambulances operating within the entire system at one time. These combinations were tested with a patient load of approximately 420 for the two day simulation. The second series tested 4 combinations using double the original patient load.

For the analysis of the results, the following five criteria were considered to be an accurate measure in evaluating the effectiveness of the system:

1. Patients evacuated vs. those ready for evacuation.
2. Average evacuation team utilization time.
3. Average patient load per trip.
4. Average delay time awaiting evacuation.
5. Average time to arrival at clearing station or hospital.

These criteria were used because it is necessary to ascertain the following:

1. Was the system able to handle the load generated?
2. If so, did the evacuation teams operate a reasonable number of hours?
3. Did the patient load per trip approach the capacity of the evacuation vehicles?
4. Were the evacuation delays too great in length?
5. Were any savings in time apparent as the mixes of vehicles changed?

7. RESULTS

After a thorough analysis of the results, we found that all systems were capable of evacuating 99% of the patients. This was undoubtedly true because of the reduced number of patients simulated during the last 18 hours of the scenario and the fact that very few patients entered the system during the first 12 hour period of darkness.

This then left us with the remaining four criteria for continuing the evaluation. As was previously mentioned, two distinct evacuation systems were operating within the model, one from the battalion aid station (BAS) to the clearing station and the other from the battalion aid station to the surgical hospital. Firstly we consider the aid to clearing station system, and see what effect air ambulances have on the system.

Shown in Table V are the results of using ground evacuation only. Note that during the two day simulation, of the total of 420 patients simulated, 372 (87%) were destined for treatment at the clearing station. Across the top of the chart are the total numbers of ambulances operating within this system and below, the results.

TABLE V

Ground Ambulance System Only

CLEARING STATION EVACUATION

48 hour system - 372 patients

	Ground Ambulances				
	6	12	18	24	30
Utilization time per ambulance (hours)	26	13	5	4	2
Average load per trip	2.2	2.0	2.0	2.0	2.0
Delay Awaiting evacuation (hours)	0.5	0.4	0.4	0.4	0.4
Time wounding to clearing station (hours)	3.4	3.2	3.2	3.1	3.1

As expected, the utilization time decreases as the number of ambulances increases, however, an interesting point is the failure of this pure ground system to reduce below 0.4 of an hour the average patient wait time. However, the average time to deliver a patient to the clearing station did lower with an increase beyond 18 ambulances.

TABLE VI

Air Ambulance System Only

CLEARING STATION EVACUATION

48 hour system – 372 patients

	Air Ambulances				
	2	4	6	8	10
Utilization time per air ambulance (hours)	29	17	12	9	5
Average load per trip	2.6	1.9	1.6	1.6	1.6
Delay Awaiting evacuation (hours)	0.8	0.2	0.2	0.2	0.2
Time wounding to clearing station (hours)	3.2	2.6	2.6	2.5	2.5

Shown in Table VI are the results of a total air evacuation net. Again the results are similar although a further reduction in wait time is apparent through two air ambulance changes and again a small reduction in delivery time to the clearing station is apparent.

Table VII shows the effect of a pure ground evacuation system, two combinations of air and ground, and a pure air evacuation system. As noted, the pure air system outperformed any combination. This is undoubtedly due to the increase in speed of air evacuation teams.

The next three tables will now show, in the same sequence as the previous system, the operation of the battalion aid station-to-surgical hospital evacuation system.

Table VIII shows the effectiveness of a Ground Evacuation System only. Note that the number of patients entering this system is 48 (13%) of the total patient load generated.

TABLE VII

Combined Systems

CLEARING STATION EVACUATION

48 hour system - 372 patients

	Combination Air/Ground			
	6 Amb 0 Hel	6 Amb 4 Hel	6 Amb 8 Hel	0 Amb 10 Hel
Utilization time per evacuation vehicle (hours)	26	8 / 19	2 / 18	5
Average load per trip	2.0	1.7 / 1.5	1.7 / 1.5	1.6
Delay Awaiting evacuation (hours)	0.4	0.3	0.3	0.2
Time wounding to clearing station (hours)	3.4	2.9	2.9	2.5

TABLE VIII

Ground Ambulance System Only

SURGICAL HOSPITAL EVACUATION

48 hour system - 48 patients

	Ground Ambulances				
	2	4	6	8	10
Utilization time per air ambulance (hours)	43	24	16	11	8
Average load per trip	1.8	1.5	1.4	1.4	1.4
Delay Awaiting evacuation (hours)	2.8	1.0	0.9	0.9	0.9
Time wounding to surgical hospital (hours)	6.0	4.4	4.2	4.1	4.1

TABLE IX

Air Ambulance System Only

SURGICAL HOSPITAL EVACUATION

48 hour system - 48 patients

	Air Ambulances				
	1	2	3	4	5
Utilization time per air ambulance (hours)	29	17	10	5	5
Average load per trip	1.4	1.2	1.2	1.2	1.2
Delay Awaiting evacuation (hours)	1.1	0.3	0.3	0.3	0.3
Time wounding to surgical hospital (hours)	3.5	2.8	2.7	2.7	2.7

TABLE X

Combined Systems

SURGICAL HOSPITAL EVACUATION

48 hour system - 48 patients

	Combination Air/Ground			
	2 Amb 0 Hel	2 Amb 1 Hel	2 Amb 2 Hel	0 Amb 4 Hel
Utilization time per evacuation vehicle (hours)	43	12 / 21	12 / 13	4
Average load per trip	1.8	1.0 / 1.4	0.8 / 1.2	1.2
Delay Awaiting evacuation (hours)	2.8	0.9	0.6	0.3
Time wounding to surgical hospital (hours)	6.0	3.6	3.3	2.7

Table IX, illustrating an Air Evacuation System only, shows the increased effectiveness of two air ambulances over one.

Table X shows combinations of ground and air evacuation systems. Here again, the addition of one and two air ambulances to the system greatly reduced the waiting time and time of arrival at the surgical hospital.

The similarity between the two systems tested is quite apparent. A logical question now would be, just what type of air/ground evacuation mix might have evolved from this evaluation?

Figure 3 shows a possible system using a total of 9 air and 16 ground ambulances, operating from three separate locations. This system should not be considered the best available since many other variations must be tested before a firm recommendation could be made. The reason that a pure air evacuation system was not considered is because weather and enemy action may in some cases preclude the use of air ambulances.

We feel as though this preliminary evaluation of the evacuation systems with an infantry division merely scratches the surface. Additional runs consuming many more hours of computer time are anticipated. The outlook for continued uses with the models is heartwarming. Future plans call for us

1. to examine the relative effectiveness of the helicopter systems under varying types of conflicts and intensities,
2. to evaluate helicopter medical systems in conjunction with typical armor and mechanized divisions scenarios,
3. to examine the relative effectiveness of the helicopter systems when locations or types of treatment installations vary,

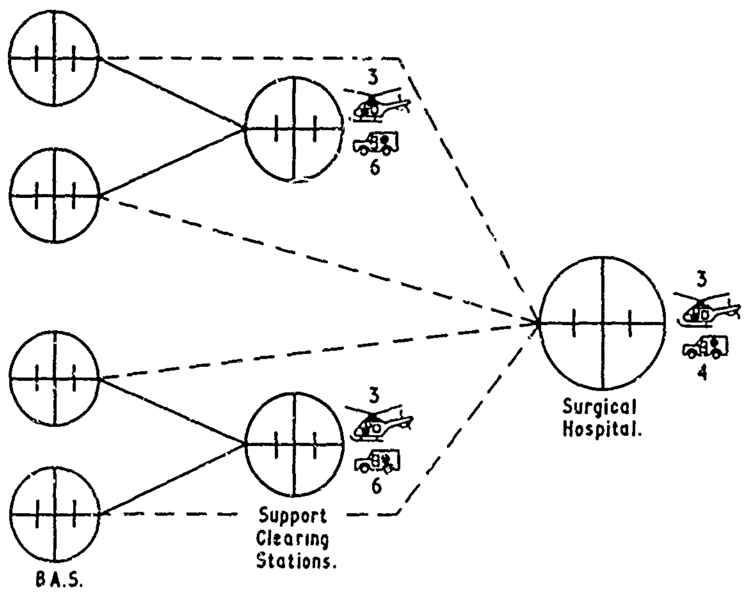

Fig.3 A possible deployment scheme

4. to examine the effectiveness of the systems when the location and base of operations of the helicopters themselves vary, and
5. to examine the utilization and idle times for various helicopter evacuation systems using scenarios of 30 days in length rather than short intensive combat actions such as was used in this particular demonstration.

SUMMARY OF SESSION II

by Air Commodore R.O.Yerbury, RAF

It was encouraging to hear of the efforts that are being made in the task of extending and modernising the provisions of the Geneva Conventions, but it is apparent that we still have a long way to go. It will be some years before we can hope that insurgent or guerilla forces, particularly in under-developed areas, will recognise the Red Cross.

In the various presentations during this session, we have heard excellent accounts of the employment of the helicopter in the rescue and casualty evacuation roles in many parts of the world, from impenetrable jungle to the arid mountain-tops of Arabia.

I was particularly pleased that our Vice Chairman raised the all-important question of Air Superiority. In recent conflicts in which the Western Bloc forces have been engaged, we have enjoyed a high degree of, if not complete, air superiority. As a result, this vital factor tends to be forgotten. We must always bear in mind, when planning operations or deciding upon casualty evacuation policy, that a high degree of air superiority is essential to successful casualty evacuation by air on any appreciable scale.

During this session we have heard of many advantages in the use of the helicopter as a casualty evacuation vehicle. In general, these advantages were common to all geographical areas, but I suggest that three of these advantages are outstanding:

(a) The clinical advantage of transporting the battle casualty out of the combat area back to a surgical unit with the minimum lapse of time.

(b) The helicopter is invaluable in maintaining the morale of the soldier going into battle: he knows that should he be wounded he will be transported to a safe area and into skilled surgical hands with minimum delay.

(c) The ability of the helicopter to extract casualties from inaccessible locations.

It is apparent that much remains to be developed and improved:

(a) There is tremendous scope for co-operation in research and development of equipment associated with evacuation by helicopter.

(b) Communications and signal procedure are all-important and an attempt at some degree of international standardisation seems desirable.

(c) Ground forces must be educated and trained in the requirements and abilities of the helicopter pilot when landing in the combat area or in difficult terrain.

I fear it will be many years before the smaller nations will be able to afford to set aside helicopters specifically for medical use. Nevertheless this must not deter the medical services from doing all in their power to ensure that, in any operation, sufficient helicopters are available for casualty evacuation at the right time, at the right place, and in sufficient numbers.

AN OVERALL SURVEY OF HELICOPTER OPERATIONS PROBLEMS

by

Colonel Spurgeon H.Neel, MC

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RESUME

Les pilotes d'hélicoptères sont exposés aux mêmes types de stress que les pilotes d'avions à voilure fixe. Les différences sont quantitatives plutôt que qualitatives, et directement liées aux différences que présentent les caractéristiques de vol des deux types d'appareil.

La portance, aussi bien que la poussée d'un hélicoptère, sont assurées par sa voilure tournante; la puissance requise est par conséquent supérieure et, dans la plupart des cas, le moteur et les systèmes de transmission sont situés à proximité de l'équipage et des passagers, les bruits, les vibrations et la toxicité se trouvant atténués au minimum. L'hélicoptère est une plateforme dont l'instabilité relative est un facteur indésirable mais inséparable de la souplesse que lui est inhérente. Ceci pose d'importants problèmes d'instrumentation et de stabilisation automatique, problèmes qui contribuent directement à créer chez le pilote fatigue et désorientation. Le poids de l'appareil est, au stade du développement, un élément plus préoccupant pour un avion à voilure tournante que pour un appareil à voilure fixe, et peut aboutir à des "compromis" en ce qui concerne les caractéristiques souhaitables, en particulier, dans les domaines présentant un intérêt médical. Le type de vol qui caractérise les opérations menées par hélicoptère – vols en rase-motte, vitesse et direction variables – exige du pilote des efforts plus grands et contribue à créer les stress auxquels il est soumis.

Ces caractéristiques, inhérentes aux opérations par hélicoptères, ont pour résultat un accroissement (1) du bruit, (2) des vibrations, (3) de la toxicité, (4) de la désorientation et (5) de la fatigue. Heureusement, ces mêmes caractéristiques impliquent une durée d'exposition moindre à ces stress multiples. L'auteur examinera particulièrement ces problèmes dans la mesure où ils affectent les opérations par hélicoptères, et où ils peuvent être influencés par les conditions tactiques.

AN OVERALL SURVEY OF HELICOPTER OPERATIONS PROBLEMS

Colonel Spurgeon H. Neel, MC

Has the helicopter created new medical problems? Do we need only apply the knowledge of fixed-wing aviation medicine to the problems of the helicopter?

The answer to both questions is affirmative to an extent, but some explanation is necessary. Rotary-wing aviators *are* exposed to the same types of problems or stresses as those flying fixed-wing aircraft but with certain definitive differences. These differences are quantitative rather than qualitative; and are directly related to the differences in flight characteristics of the two types of aircraft.

What are these differences in flight characteristics between rotary-wing aircraft and fixed-wing aircraft?

THE HELICOPTER

Helicopters employ a rotating wing from which is suspended the personnel and cargo compartment. Contrary to fixed-wing aircraft, the rotating wing must provide both lift and thrust; hence the helicopter's relatively greater power requirement, and the resulting magnification of those problems that are directly derived from the power source.

The most impressive characteristic of the helicopter is its ability to move independently (and theoretically, equally) in any of the three axes of motion, or maintain stationary flight. This greater freedom of motion creates a relatively unstable platform - to such an extent that instrument flight was initially considered improbable except under very dire circumstances. Although advances in technology and training now permit almost routine instrument flying there is still no real trimming capability as in fixed-wing aircraft and as yet no auto-pilot.

Weight is a more critical factor in the development of rotary-wing than fixed-wing aircraft, and has frequently resulted in trade-offs of "non-essential" items of equipment or characteristics. Unfortunately, these trade-offs are often in areas that compromise many of the desirable personal protective features of fixed-wing aircraft, such as sound-proofing materials structural reinforcement, and the like.

The usual military employment of helicopters requires flight at tree-top level, ("nap of the earth", terrain or contour flying) with varying speed and direction. This is necessary to reduce vulnerability to ground fire and to increase the element of surprise. A substantial demand is placed upon the operator at an altitude that leaves very little margin for error.

These characteristics result in more noise, more vibration, more toxicity, more disorientation, and more fatigue.

THE MEDICAL PROBLEM

Noise, a by-product of energy, is directly related to the power plant of an aircraft. Since, pound for pound, helicopters require more energy than fixed-wing aircraft, this increased problem of noise becomes very apparent.

Overall noise levels in Army aircraft have been studied extensively by the United States Army Aeromedical Research Unit at Fort Rucker, Alabama. The results of their study of the CH-47A helicopter, clearly indicate the magnitude of the problem we face. The CH-47 is a large, 33-passenger, tandem-rotor helicopter powered by two gas-turbine engines, each producing approximately 2,200 shaft horsepower at 18,750 rpm at maximum rated power. The overall internal noise levels during normal cruise at 500 ft altitude, 350 psi torque and 100 knots IAS, have been recorded at 118 dB at positions directly beneath the forward and aft transmissions. In the fuselage between these high intensity areas, the overall noise levels are 110 dB or greater Octave band analysis of the noise indicate levels as great as 115 dB in the 1200-2400 c/s range and as great as 108 dB in the 37.5 to 75 c/s range. The acoustical energy produced within the higher frequency ranges, especially from 1200 through 4800 c/s, is characteristically indicative of noise generated by the forward and aft transmissions and gear-distribution systems. The lower frequency ranges of 37.5 to 75 c/s reflect noise emanating from the rotors.

Studies of the single rotor UH-1D helicopter, resulted in essentially similar findings but at somewhat reduced levels. The noise generated by the rotors is also predominately in the low frequency range but the noise produced by the anti-torque system is usually distributed within the higher frequency ranges. Thus, any method designed to reduce the total noise of a helicopter with main and anti-torque rotor systems must consider both of these noise sources.

Of equal concern to the overall noise in helicopters in the loss of the noise defense mechanisms of isolation and distance that are present in many fixed-wing aircraft. Engines on fixed-wing aircraft may be mounted outboard on the wings, providing distance insulation from the crew compartment. This is not possible in helicopters because of the engine mounting within or on the fuselage.

The noise problem is further aggravated by the fact that helicopters are frequently flown with open doors and windows, again, eliminating any isolation of the aviator from surrounding noise.

It is readily apparent that ambient noise levels in helicopters exceed the accepted damage risk criterion of 90 decibel. To reduce this hazard reliance must be placed upon ear plugs, protective helmets, and, indirectly, the shorter duration of flight presently characteristic of rotary-wing aircraft.

The problem of internal helicopter noise is not limited solely to crewmembers. Combat troops, carried into battle by assault helicopters, will also be exposed to this same noise, plus one further possible effect that may easily be overlooked - the

temporary threshold shift. Previously, air movement of combat troops by fixed-wing aircraft involved movement to a site nearest their area of utilization. Voice communication, inflight and upon landing, was not of immediate concern. However, in a helicopter assault the final landing site may changed inflight or may not be determined until minutes before landing. In either case, relaying this detailed information to each member of the assault party is not made easier by the high internal noise levels.

Further the delivery of troops to the immediate combat area, frequently under enemy fire, requires that forces be immediately reconstituted and objectives indentified. Voice communication is essential and any loss of auditory acuity resulting from a temporary threshold shift will only add further confusion to the existing situation.

When the problem of communication within the aircraft was initially studied it was suggested that the aircraft intercom system be augmented with an additional communication cord extending the length of the aircraft. From this each individual would have headsets for receiving en route and last minute instructions. This has not been adopted. Instead, the assault leader makes use of a hand held blackboard, on which he transmits appropriate information with generally satisfactory results. The most practical solution for the problem of the temporary threshold shift appears to be use of disposable ear plugs, which can be abandoned immediately prior to exiting the aircraft.

Vibration has received less attention than the audible sound energies but its effects upon both the man and machine are no less real. It is generally recognized that rotary-wing aircraft produced vibration characteristics of greater displacement than fixed-wing aircraft, and, again, magnification of the resulting problems.

Unfortunately, neither the resulting discomfort and fatigue nor their effect on mission accomplishment are easily measured. However, the adverse effect of vibration upon visual acuity has been documented. We know that it will reduce an individual's ability to read his instruments. Further, we know that vibration is maximal during the critical periods when acquiring translational lift from a hover, and, again, during landing, when collective pitch is increased and power is added upon nearing the ground.

This effect of vibration upon visual preception assumed particular significance when the helicopter was modified to serve as a weapons platform. It was obvious that merely hanging armament on a helicopter added little if the weapons fire failed to reach its objective. Therefore, a great deal of effort was expended in developing our present weapons sighting devices; and minimizing the adverse effect of the inherent vibration on visual preception was of paramount concern.

It is of interest, that vibration may also have a beneficial effect. One study of helicopter pilots found that they utilize the vibration which they perceive as a sensory evaluation tool. Seemingly, the modes of vibration preceived can assist the pilot in evaluating his normal flight patterns during control of the aircraft, as well as assist in the detection and diagnosis of possible system malfunctions. This is truly a return to the "seat of the pants" method of flying.

Medically we can probably do the least in this area but will have to rely upon improved shock-mountings of engines and seats, increasing the comfort of existing seats, damping of the fuselage walls by insulation, and similar engineering advances.

Toxicology, long of interest in fixed-wing aircraft is also magnified in the helicopter because of its ability to maintain slow, stationary, or even reversed flight. This allows the helicopter literally to wallow in its own excreta. The engines location immediately within the fuselage can contribute further to this problem.

One of the special considerations in this respect is demonstrated by the UH-1 aircraft. Air intakes for cabin ventilation are located below the exhaust. Although the exhaust is expelled rearward, the rotor wash is downward, thereby creating a potential source of contamination, particularly during slow or stationary flight. Fortunately, the introduction of gas turbine engines has reduced the carbon monoxide content of the exhaust because of more complete combustion but we must still consider the other toxic products that may be produced by the engine.

A new area of toxicology was also introduced when the helicopter was modified as a gun platform. The toxic hazard created by the exhaust gases during firing was not initially considered significant because of the brisk ventilation as a result of open doors. However, this was subsequently questioned when pilots reported an odor of cordite and a visible haze in the cockpit in association with firing, in addition to occasional respiratory tract irritation and nausea.

As a result, the Army Aeromedical Research Unit has teamed with the Air Force Propulsion Laboratory at Edwards Air Force Base, California, to examine the exhaust gases produced by the various types of munitions and to determine their exact chemical composition and degree of toxicity.

This involves collecting the exhaust of gunpowder and missile propellants under both laboratory and field conditions. These gaseous products are then analyzed, utilizing the high resolution mass spectrometer, gas chromatograph and infrared spectrometer, and determination made of their concentrations under various environmental conditions.

This project is still not complete but depending upon their results, weapons systems may require modification or methods developed for filtering these noxious gases from the aircraft environment.

Spatial disorientation has long been recognized as a hazard in fixed-wing aircraft. Again, the helicopter can magnify the problem because of its ability to produce almost instantaneous changes in any of its axes. Eastwood and Berry, in 1960, interviewed 17 Air Force helicopter instructor pilots and found that all had experienced one or more episodes of disorientation. These occurred at night in weather, or under the hood in simulated instrument conditions. They reported 52 episodes (an average of three episodes per pilot) and approximately 30% were classified as greater than mild. Another report cited four helicopter accidents that accounted for 19 fatalities in which disorientation was a major cause.

The United States Army Board for Aviation Accident Research has reviewed its records of Army aircraft accidents and identified 36 accidents in which disorientation played a role. This group comprised only 3.4% of the major accidents, yet they accounted for 30.7% of the fatalities. Concurrent with their review of accident records, 350 helicopter aviators were interviewed concerning their disorientation experiences. Two-thirds admitted experiencing disorientation (an average of two and one-half times). Again, most of these occurred at night or in adverse weather conditions. To avert accidents,

they were able to give the aircraft control to another pilot, rely on their instruments until the feeling passed, or else regain visual contact with the ground before completely losing control of the aircraft. It is readily evident that the instability of the platform plus the greater difficulty of instrumentation can overwhelm an aviator's capabilities in a very short time.

Adding to this, the operational use of helicopters at tree-top level allows very little tolerance for disorientation. This is made even more critical when the operation involves large numbers of helicopters in formation flight. Under such situations disorientation in one aviator can invite a massive catastrophe. I will not discuss the effect of dust, white-out, or bubble fogging, but all of these can cause immediate disorientation and at a very unforgiving altitude.

It is of interest that anxiety is probably a bigger factor than attitude in contributing to disorientation. This can only be overcome by proper and repeated training, particularly instrument training, to counter its effect. Concurrent with our concern for the human aspects, there must also be improvements in present aircraft instrumentation.

All of these problems contribute directly or indirectly to our old nemesis - fatigue. This should be no surprise since anyone who has attempted to fly a helicopter will readily admit that it involves 100% flying, 100% of the time. As stated earlier, trimming is not available; constant vigilance on the controls is essential; there is increased muscular tonus as a result of the sustained attention; and the low levels of flight that are imposed tactically all predispose to fatigue.

Unfortunately, it is very difficult to attribute accident causation to fatigue. However, it is more than coincidence that fatigue appears so frequently as a possible contributing factor on the accident investigation reports. Certainly, fatigue will play a role in the "cumulation theory" of accident causation, where a series of relatively insignificant adverse events finally overwhelm the aviator and an accident results.

Flying hour limits are not the answer to this problem. Although these are a convenient measurement of one of the aviator's activities, it ignores the multitude of other factors that individually are of equal importance, and, combined, exceed the factor of total flying time.

The answer to this problem is command awareness and supervision of the problem with the direct assistance of the flight surgeon, operations officer, safety officer, and subordinate flight leaders. I will say no more since this will undoubtedly be discussed elsewhere in greater detail.

I believe my comments can be summarized by quoting Marcus Titius Platius, who in 250 BC, stated "Flying without feathers is not easy". Today, "Flying without wings is even more difficult".

DISCUSSION

Wg Cdr Burton asked about the development of improved instruments and automatic aids to ease the pilot task in helicopters. Capt. Buckley stated that the H53 is planned to have a Doppler navigation system, and an improved autopilot with a 'hover-coupler' facility. Lt Cdr Williams said that the Royal Navy Wessex aircraft had excellent autopilots, primarily intended for use in the anti-submarine role. Lt Col Shamburek stated that there was a lack of suitable equipment for the light and utility classes of tactical helicopter. Bri. Gen. Lauschner suggested that integrated display systems being developed for VTOL aircraft may bring benefits for helicopters.

Cdr Mackie asked about effects of noise on helicopter passengers. There had been complaints from many users, from Royal Marine Commandos to passengers in the Royal Flight helicopters. On partial solution appeared to be the use of glass fibre 'down' as insulation. Wg Cdr Watson asked whether there was evidence of long-term hearing damage in exposed personnel. Lt Col Bailey replied that the US Army was currently initiating a study on this subject – it was possible that cases of hearing loss would be detected. Brig. Gen. Lauschner commented that acoustic trauma from small-arms firing was a much more serious problem. Lt Col Bailey agreed, and recalled impact noise levels of 170 dB having been mentioned at an earlier meeting. Capt. Perry also agreed and stated that in the Army the problem was often one of finding military personnel of adequate experience suitable for flying training who did not have pre-existing hearing deficit. Col Eberling and Col Neel agreed that the same was true of their services. Maj. Asdahl expressed the opinion that cotton ear plugs, issued to personnel for use whilst shooting and also whilst flying as passengers, had proved very effective in preventing acoustic trauma in the Norwegian forces.

Capt. Buckley asked whether anyone present had experience to offer with regard to the use of diagnostic aids in helicopters in flight. Capt. Ireland stated that the US Navy was currently working on a high-background noise level stethoscope.

There was considerable discussion on the measurement of toxic contaminants in helicopter cabins. Lt Col Bailey described a developed hopcalite system for CO measurement and other techniques for nitric oxides, particulate metal etc. Maj. Asdahl asked about the use of colour-change type detector tubes. It seemed generally agreed that they were of insufficient accuracy for most studies, particularly on transient levels. It was acknowledged that a useful check on the significance of the CO hazard was to assay HbCO in the blood of exposed personnel.

Capt. Buckley asked for views on body armour. Capt. Mattox stated that the 7 lb 'flak-vest' had proved reasonably successful against low velocity fragments but that the laminated ceramic 'Armoured chest protector' was more useful in that it offered protection against modern high velocity missiles. Ballistic protection helmets were currently under development.

OPERATION OF HELICOPTERS - SOME VISUAL PROBLEMS

by

Surgeon Cdr W.A.N.Mackie, RN
Royal Naval Air Station,
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RESUME

Les informations visuelles dont dispose le pilote d'hélicoptère sont décrites et examinées. Les problèmes que l'on rencontre fréquemment dans les opérations hélicoptères sont associés aux aspects visuels de ce genre de vol. L'auteur insiste sur l'importance d'un champ visuel suffisant dans l'hélicoptère.

La possibilité de sélection et d'entrainement dans la perception du mouvement, est indiquée.

OPERATION OF HELICOPTERS -- SOME VISUAL PROBLEMS

Surgeon Cdr W.A.N.Mackie, RN

Helicopter flight because of its operational role, still mainly occurs close to the ground or surface of the sea, i.e. in visual contact. Though night and bad weather flying is now possible by instrumentation, and in some configurations automatically, the final approach to the hover and to the touch down requires direct visual contact. even in sophisticated landing areas. From external visual cues the helicopter pilot must compute his rate of approach to the touch down point (i.e. rate of height change, rate of forward deceleration, amount of heading alteration) to enable him to come to the hover and then land. In good visual conditions the pilot can carry this out with little difficulty. However trials of a blind approach to a pad under guidance on a 20° glide path by BEA experimental unit (Lennox, 1962) on a prepared pad showed that at breakout, errors of 15° in heading with 150 ft in azimuth were possible and this gave the pilot little time to decide from external cues whether to continue or abort the approach.

Thus, operationally in the field bad-weather and large-scale night flying are limited at present because of this requirement to use external cues. Similarly, on take off the pilot must gain the hover, ease the aircraft into forward flight, prevent it sinking as it comes off the ground cushion effect and avoid obstacles in the take off pathway.

During forward flight over a level surface the pilot sees a phenomenon known to all car drivers, the apparent flow of stationary objects, or the surface relative to the pilot's eye - and these give important cues to the velocity, direction of movement and the approach of the vehicle to other objects or surfaces. In the case of the car one is normally dealing with movement in two planes; in the aircraft movement and change of movement in all three planes can be detected.

This phenomenon was first studied in relation to aircraft by Gibson, Olum and Rosenblatt (1955) who investigated the use of multiple parallel clues to perspective in a study of fixed wing aircraft landings. They constructed a series of diagrams to illustrate the differential velocities at different points of the Earth's surface for various fields of view relative to the line of motion. Each diagram representing velocity vectors is a projection of the ground on a picture plane in front of the eyes. These were later proved by mathematical analysis.

Two points must be made:-

1. Movement parallel to a surface gives rise to pure flow.
2. Movement directly towards or away from a plane at a right-angle to the flight path gives rise to apparent radial movement outwards or inwards to the observer.

If the pilot takes off into the hover he will perceive a radial movement inwards till the required height is reached. In the hover his visual world must be motionless, any linear flow means movement either forward or sideways; any radial movement a change of height. As he goes into forward flight, linear flow increases with speed, his height relative to the surface giving rise to distortion of the flow. In the case of an approach, the projection of the ground appears to expand radially from a centre at the intersection of the approach path with the ground - to reach a maximum between that point and the horizon and then to vanish at the horizon (Fig. 5). In the vertical movement towards a surface, as in landing from the hover, the differential velocities extend radially, small close to the centre and increasing outwards to about 60^{o} visual angle from the horizontal to vanish again at the horizon.

The perspective of motion, which is a function of multiple parallax, is one of the more important clues of helicopter control. Because of their rate values the pilot learns to react to these by the required amount of control response to carry out the manoeuvre.

It must be added that in addition to motion perspective, other distance clues such as perspective of size and density and the binocular disparity of retinal images, must all play a part in the final judgement of approach to the surface. Without these additional clues, changes of height, for instance, can be appreciated but exact heights above the surface may be difficult to gauge. For example, a pilot going into an empty landing area hit his tail rotor on the ground, normally there were other aircraft or ground personnel about, this day there were none. For the same reason, flying over the sea with waves of an unknown height the pilot may be unable to judge whether he is at 50 ft with 2 ft waves or at 1000 ft with 10 ft wave-caps. A series of experiments in which pilots were asked to hover over a grass field as close to a coloured marker flat on the ground as possible, their estimate of their heights showed a marked variation, though they all maintained a reasonably steady hover.

It has been noted that many early helicopter pilots did not like to fly above 2000 ft and in some cases complained of vertigo. It is suggested that above this height the helicopter pilot's rate of motion perspective becomes decreasingly apparent and that this is why this "break off" phenomena occurs. However, with better instrumentation and instrument flying practice, the helicopter pilot transfers to the fixed wing pilot's mode of flying.

However, less of motion perspective occurs in the absence of texture e.g. flying over snow or calm sea. Crews operating from HMS Protector in Antarctica found that they could not maintain a stationary hover in Whirlwind (S51) aircraft but tended to land with a lateral movement on the aircraft, usually towards the right, the pilot having to look to the right side, due to the engine cowling obscuring forward and downward vision, and in so doing tending to bring the stick across to the right. To avoid this it was customary to have in the back of the aircraft a drum of waste oil which was split out over the landing area before touchdown was attempted.

Under certain circumstances at sea clues of motion perspective can give rise to illusions of movement e.g. a helicopter in the hover in a cross sea, may well be apparently moving against the swell. The opposite can also happen, e.g. in calm conditions, in the hover the rotor downwash can set up a radial disturbance of the sea surface which appears from below and behind the pilot, giving rise to the

impression that the aircraft is losing height and going backwards. It is a practice in normal operation of the aircraft in the rescue role for the pilot to watch his line up, whilst height and ground speed are given by the aircrewman in the back.

It is suggested that some accidents have been caused by false motion perspective clues. A series of crashes occurred in US Army helicopters that were in night formation. The formation lost touch with the leader and on breaking cloud a number crashed, - they were flying over a dark area with a limited number of lights on the ground. It was suggested that the reflections of these lights in the transparencies, giving rise to a false motion perspective, led to disorientation of the pilots.

The implications of this important visual clue are:-

(i) that pilots during their training are made aware of the phenomenon and the possible illusions. Even experienced pilots are unaware of some of the important approach clues.

(ii) that landing areas should have suitably textured surfaces and, ideally, some size indication. Obviously a human being is the ideal.

(iii) as the phenomenon is also valid at night, lighting patterns must be dispersed to allow line up and movement on X and Y axes to be lined up early.

This means that approach paths to a landing platform on a frigate should never be from astern - as the expansion of the touch down point i.e. the landing platform, only occurs late in the approach, and appreciation of the rate of closing the ship from the beam, allowing the whole ship's length to be in the picture projective. In practice the approach from two miles is carried out on 140° on the bow, with a glide path indicator set up to give position on the glide path. The helicopter is brought into the hover close to the side of the ship which is steering 10° out of wind, and the aircraft moves sideways onto the platform.

Lastly the question of how much does the helicopter pilot require to see must be examined in the light of motion perspective.

In aircraft with a downward cut off of $42^{\circ} - 47^{\circ}$ from the horizon in a series of pilots, they were able to use between $32^{\circ} - 39^{\circ}$ angles of sight to maintain the hover on a ground marker, at hover heights between 3 ft 6 in. to 17 ft. This agrees with Sunkes and Pazeras work in a study of helicopter pilots' eye movement when they postulated a minimum downward cut off of 35° + 'a' where 'a' was the average nose-up attitude flown by pilots consistently in the type, and this should extend from 10° left to 15° right of the vertical eye reference line. However, this gives a very limited motion perspective. It was found that at approach paths of over 20° in S.55 aircraft, that the pilots use their side transparencies when carrying out steep approaches - if necessary yawing the aircraft to do so. This allows them to look sideways and more vertically - both leading to an increased motion perspective.

Finally, it is suggested that visual requirements of helicopter pilots must be looked at in the light of motion perspective - and that suitable test devices could be readily designed to teach, test and if necessary eliminate those pupils who show a poor response to these visual clues.

ACKNOWLEDGEMENTS

Figures 1 and 5 are reproduced by courtesy of Houghton Mifflin Co., Boston, from Reference 5. Figures 2, 3 and 4 are reproduced from Reference 4, by kind permission of the Editors of the American Journal of Psychology.

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The discussion following this paper appears on page 164.

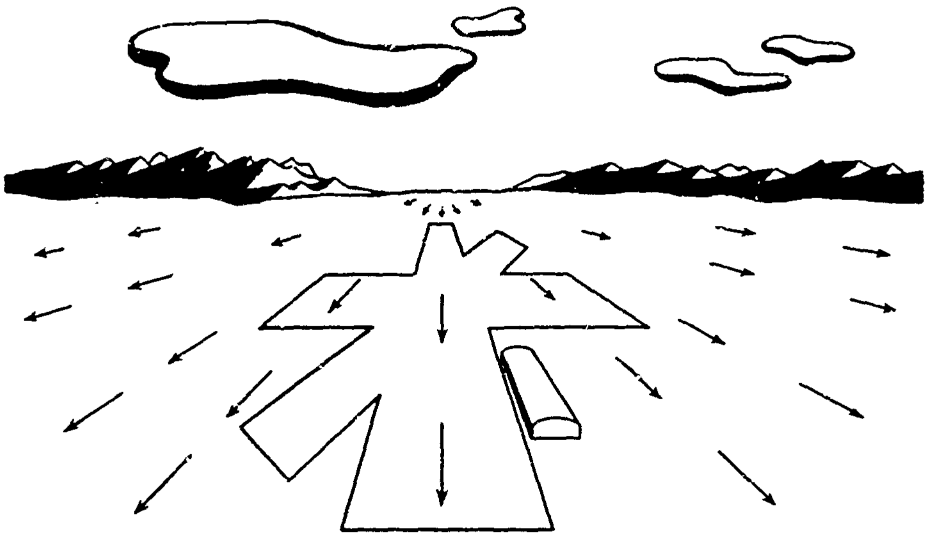

Fig. 1 Shows the motion perspective in relation to an aircraft flying parallel to the earth's surface. The ground ahead seems to expand radially from a centre at the horizon. The ground to right and left seems to be skewed

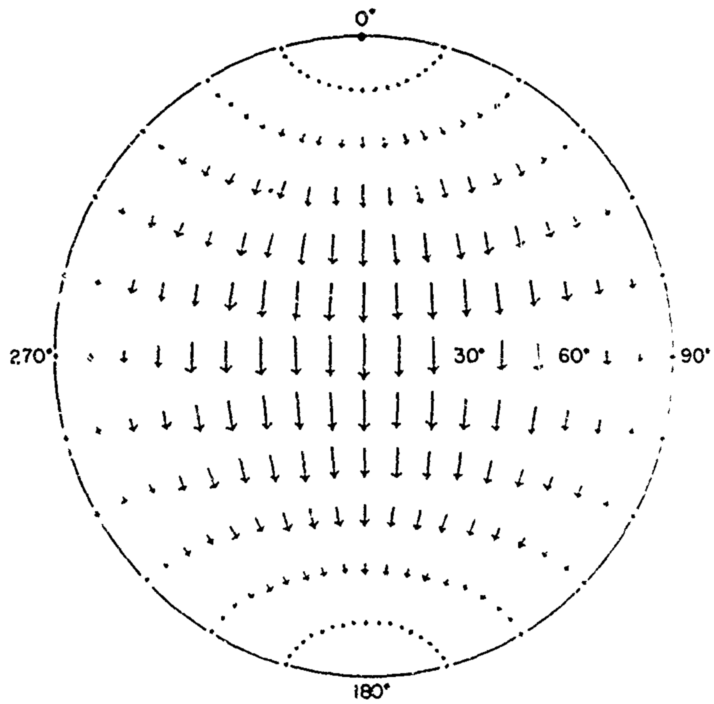

Fig. 2 Shows the differential velocities from an observer in the centre of the circle, the aircraft in level flight towards 0^{o}. Distances from the centre of the circle represent the angle between the line of sight and the vertical. It can be seen that from behind the beam position the ground motion seems to track radially towards another centre at the 180^{o} position on the horizon

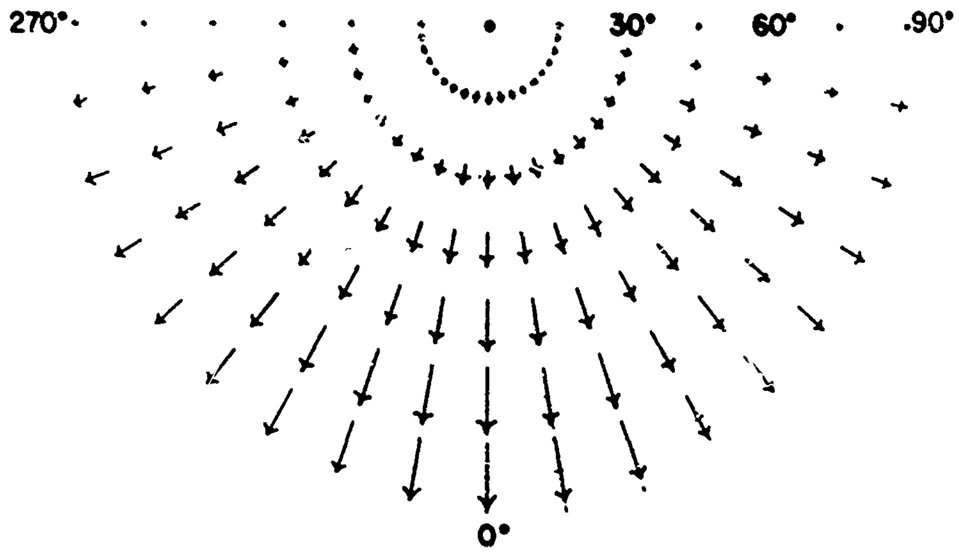

Fig. 3 The pattern of velocities during level flight. The pilot's view

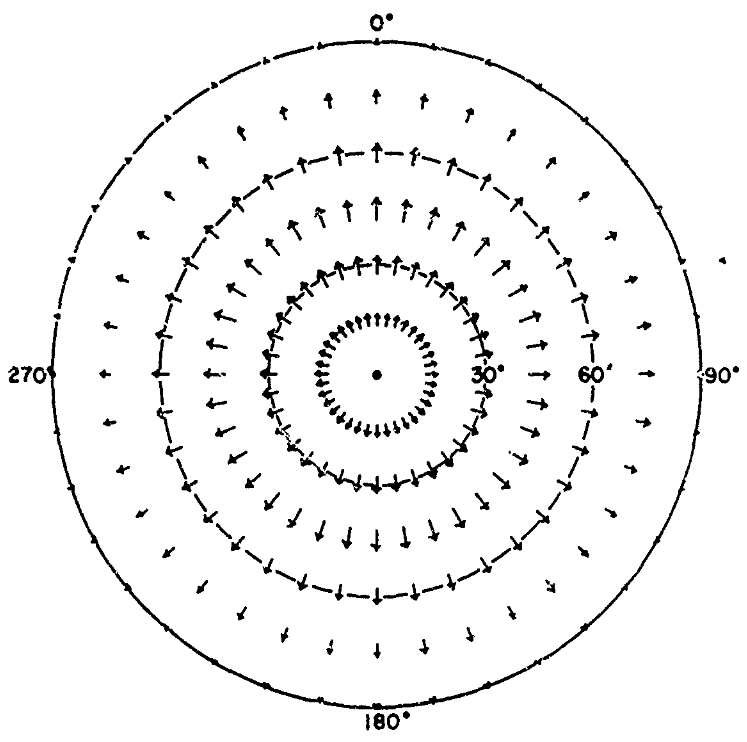

Fig. 4 Shows the differential velocities in movement towards a frontal surface perpendicular to the line of locomotion; i.e. in this case the vertical landing of the helicopter - the apparent velocities spread radially from the centre to be maximum at some 45^{0} to 30^{0} angle of sight with the horizontal, but in the forward moving vehicle any obstruction at right angles to the flight path gives rise to the same radially expanding pattern

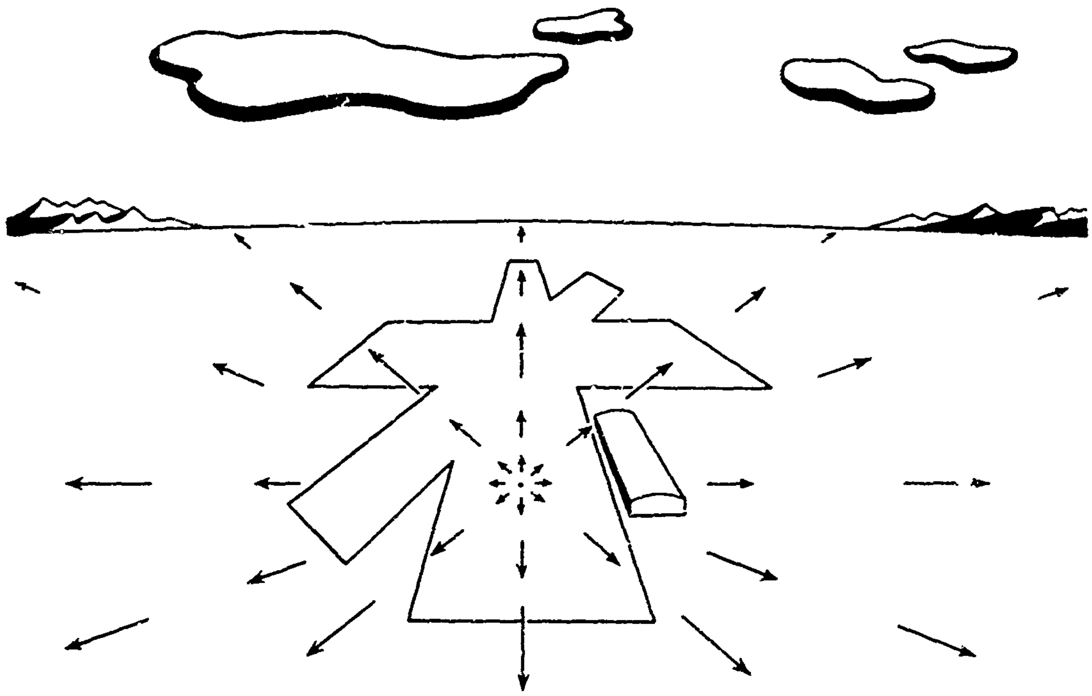

Fig. 5 Shows the motion perspective during an approach glide. Note the displacement of the centre as compared with Figure 1

DISCUSSION

Wg Cdr Burton asked the speaker whether there was evidence that visual acuity of the type required in the situation under discussion could be improved by training. It was important to pursue such techniques if they were effective because it might enable the initial requirements in visual standards to be relaxed somewhat. Cdr Mackie thought that improvement was possible although he could quote no figures. Air Cdre Roxburgh asked about the importance of binocular vision in helicopter flight, particularly distance judgement. Cdr Mackie emphasised that motion parallax detection was a monocular function, and thought that binocular depth appreciation was relatively unimportant.

In reply to a question from Brig.Gen.Lauschner, Cdr Mackie suggested that one of the most practical tests of the visual skills required in helicopter flying was the skill in car-driving, even though the latter was a two-dimensional task.

VIBRATIONS SUR HELICOPTERE

par

H.Seris et R.Auffret, FAP

SUMMARY

A preliminary report is made on the vibration characteristics of a new French military helicopter, the Sud Aviation 330.

Vibration levels are found to be relatively high by comparison with the S.A. Super Frelon. There is, in particular, vibration in the frequency band of 17.5 to 20.7 Hz.

The high incidence of back pain in helicopter pilots (87.5% in one survey) is discussed, and mechanisms and treatment are reviewed.

VIBRATIONS SUR HELICOPTERE

H.Seris et R.Auffret, FAF

Nous avions il y a 2 ans présenté a l'Aérospace Medical Panel une étude réalisée sur l'hélicoptère lourd Sud Aviation 3 210 Super Frelon. Nous envisagions de vous exposer aujourd'hui un travail identique à propos du SA. 330 hélicoptère de manoeuvre destiné a l'Armée de Terre. Le programme d'essais de l'appareil qui nous était destiné ne nous a jusqu'à présent permis qu'un seul vol de mesures et ce vol a été réalisé le samedi 20 mai 1967. Il ne nous a pas été possible de dépouiller la totalité des enregistrements qui comportent plus de 300 spectres, et nous ne pourrons vous donner que quelques résultats fragmentaires, que nous comparerons à ceux relevés sur le Super Frelon.

Le SA. 330 est un hélicoptère de tonnage moyen (6.4T), de rayon d'action 400 Kms à 270 Km/H. Cet appareil permet de transporter 12 commandos et leur équipement. Il existe une version sanitaire capable d'emporter 6 blessés ou malades couchés et 4 passagers assis. L'équipage enfin comporte 1 pilote, 1 copilote, et 1 mécanicien.

Il s'agit d'un hélicoptère a 2 turbines, d'une puissance de 1300 CV.

Signalons enfin que le rotor tourne à 260/270 tours/minute, qu'il comporte 4 pales ce qui nous laisse prévoir une frequence de 17 à 18 Hz. Le rotor de queue a une vitesse de rotation de 1300 t p m et compte 5 pales; il generé une fréquence beaucoup plus élevée de 108 Hz.

INSTALLATION D'ESSAIS

Nous ne la décrirons pas à nouveau. Elle comporte 6 voies de mesures dont chacune est constituée par:

1 accéléromètre à mutuelle inductance J.222 ± 2,5 g. A C B

Alimentation sur 28 V.

Porteuse 2000 Hz. D 11 bloc démodulateur D.5 461 A C B. Amplificateur W.6 200 S A T et filtres 0.200 Hz à 5%.

Les tensions électriques fournies par ces chaînes de mesures de conception très classiques sont enregistrés en modulation de fréquence au Standard IRIG sur l'enregistreur magnétique embarquable tolana A.4022.

La bande magnétique comporte en plus des 6 voies de mesures une voie phonie et des tops permettant le dépouillement automatique. A la sortie de l'interface Z 0600, les bandes magnétiques codées sont traitées sur IBM 70:70.

Par ailleurs, sur enregistreur lecteur Ampex F. R 1300 la bande magnétique analogique peut être visionnée sur magascope Teleco 15 voies, les portions intéressantes mises en boucles et les spectres de fréquence sont analysés par un QUANTECH. 304 et tracés sur table traçante XY Hewlett Packard: en g par Hz ou en g^2 par Hz ce qui donne une meilleure représentation de l'énergie correspondant à l'excitation.

Nous avons par ailleurs mis au point des programmes de traitement à partir des bandes codées. Ces programmes nous fournissent à la sortie de l'IBM 70:70: une fonction d'autocorrélation, une densité spectrale par décomposition en serie de Fourier, une analyse statistique des distributions d'amplitude sur le signal global ou le signal filtré.

Chacune de ces explorations est susceptible de fournir des renseignements intéressants pour juger de la nature des processus vibratoires de leur transmission à travers les masses de systeme homme-siège, de l'efficacité des dispositifs de protection, enfin et surtout du risque de perturbation physiologique pour le pilote.

Les 6 capteurs sont répartis en deux blocs de trois correspondant aux trois axes du triède de référence avion. En ce qui concerne la SA. 330, trois niveaux ont été enregistrés: plancher-siège, ce qui permet d'étudier la fonction de transfert du siège, plancher-tête du pilote, qui rend compte de la transmissibilité du systeme homme-siège.

Toutes les configurations de vol ont été explorées lors du premier essai depuis la mise en route des jusqu'à l'atterrissage: pallier virages, transitions VNE ... et ceci dans les limites de la sécurité.

RESULTATS

Les premiers dépouillements sont intéressants, car ils confirment l'opinion subjective des pilotes. Le prototype du SA. 330 que nous avons essayé, présente un niveau vibratoire plus élevé que le Super Frelon. L'abaissement de la fréquence du rotor principal de 20,7 à 17,5 Hz est fort bien ressentie par les pilotes. Nous avons déjà pu nous faire une idée de la fonction de transfert du siège. Alors que nous constatons un amortissement du siège de Super Frelon sur les axes X et Z, celui du 330 à tendance à transmettre intégralement et parfois à amplifier les excitations qu'il reçoit. Nous retrouvons sur le siège plus particulierement en Y une bosse à 8 Hz très proche des résonnances du corps humain telles qu-elles ont été définies par Dieckman, Goldman et Von Gierke et que les expérimentations de Wisner, Coerman, Clark, White, Hornick et Parks ont mis en évidence.

PHYSIOPATHOGENIE

Les travaux des expérimentateurs que je viens de citer, la thèse de Sliosberg, les essais réalisés à la Régie Renault par le Dr Tariere et l'étude radiologique en cours à l'Hôpital Dominique Larrey à l'instigation de mon excellent ami, le Professeur Delahaye, nous permettent de prévoir les effets anatomopathologiques, de ces vibrations. Il est un second domaine dont les travaux de Guignard et de Harris et Shoemberger ont montré l'extrême importance, il s'agit des performances.

Sur le plan anatomo-physiologique Sliosberg a écrit que 87.5% des pilotes d'hélicoptère, sont des dorsalgiques. Il fixait le seuil d'apparition des douleurs à la 300ème heure de vol, avec un rythme de vol de 4 à 5 h. par jour, 40 à 50 h. par mois. Je me souviens que lorsque j'ai cité ces chiffres M. Le Medecin Général Evrard les a trouvé très élevés par rapport à ceux des forces aériennes Belges. Il pourra peut être nous dire tout a l'heure son opinion avec un recul de 2 ans. Ces douleurs, Wisner les explique par le rôle d'amortisseur que les muscles périvertébraux sont appelés à jouer. Lorsque le bassin du pilote est excité par une force correspondant à 0,6 g et que sur la tête on ne retrouve que 0,1 g ou moins, il y a nécessairement quelque part une absorption d'énergie. Ceci au depend de la musculature périvertébrale et des disques intervertébraux

Des études récentes menées en France sur le réflexe myotatique et les fréquences d'entrainement semblent montrer que les fréquences de 6 ou 7 Hz correspondent non point à des fréquences propres du corps en fonction des masses mises en jeu, mais à un phénomène intrinsèque de régulation du système nerveux central. Que ce soit par fatigue musculaire ou par défaillance du systeme de régulations la musculature périvertébrale cesse au bout d'un certain temps de jouer son rôle d'amortisseur.

Les vibrations agissent alors directement sur l'ensemble vertèbre, disque intervertébral.

Il est hors de doute que l'hyperpression sur la partie antérieure du disque intervertébral, en position assise surtout avec flexion vers avant est en relation directe avec le refoulement vers les racines nerveuses du nucleus puposus, ainsi que Keegan l'a montre. Sur le plan du pilotage des hélicoptères, cette position correspond aux configurations de vol à proximité du sol et de ce fait à des périodes d'amplitudes maximales des vibrations de très basse fréquence.

En ce qui concerne les performances, Guignard a mis en évidence l'action néfaste des vibrations sur la vision.

Harris et Shoenberger ont montré la détérioration des performances globales pour des vibrations de très basse fréquence 5, 7 et 11 Hz, en régime sinusoïdal, ou lorsque le sujet est soumis à des vibrations irrégulières.

SIGNES CLINIQUES, EVOLUTION, TRAITEMENT

Les manifestations sont bien connues: douleurs diffuses de la colonne, qui peu à peu se localisent dans les régions cervicales, dorsales ou lombaires. Les dernières étant le plus souvent atteintes.

Au stade suivant: la raideur articulaire, les algies permanentes exsacerbées par les efforts ou le vol sont la règle, accompagnées parfois d'irradiation sciatique.

La radiologie met en évidence une fréquence anormale des déviations scoliotiques lombaires et Montagard signale en outre des signes discrets d'arthrose.

L'évolution est fonction de la cadence des vols, aggravées par la fatigue, les efforts, le vol à basse altitude dans les turbulences. Les douleurs sont calmées par le repos ou le changement d'activité.

Sur le plan thérapeutique, deux attitudes sont à envisager. En période aigüe les calmants, les curarisants de synthèse, la physiothérapie ainsi que les manipulations vertébrales et les tractions jointes au repos allongé complet, entraînent la disparition de phénomènes douloureux. Toutefois seul un traitement de longue haleine protègera le pilote contre les récidives. Il doit être entrepris très tôt et continué pendant des mois. En fait tous ces sujects sont condamnés à la gymnastique vertébrale à perpétuité. L'interruption de celle-ci ne tarde pas à se traduire par la réapparition des douleurs surtout si le pilote continue à voler.

La résistance aux vibrations est nettement accrue par une bonne musculature abdominale et péri-vertébrale.

PROPHYLAXIE

Il y a lieu également de réduire le plus possible les sources de vibrations dans la machine elle-même. Le siège doit être tout spécialement étudié et son rôle amortisseur est essentiel surtout dans les très basses fréquences.

CONCLUSION

Cette première évaluation du SA. 330 met en évidence les deux classes de vibrations relevées sur la plupart des hélicoptères et avions.

Des excitations de très basses fréquences communes à tous, dont les turbulences atmosphériques et les phénomènes aérodynamiques sont à l'origine.

Leur amortissement est difficile à réaliser. Il est impossible d'abaisser de façon importante la fréquence propre d'un siège sans accroître sa masse considérablement. La solution d'un siège monté sur suspension hydropneumatique pourrait être envisagee.

Les vibrations de 17 Hz et au-dessus sont d'origine mécanique: rotor principal, anti-couple et appareil moteur.

Ces fréquences sont au-dessus des résonnances du corps humain, elles sont moins bien perçues, mais ces vibrations n'en contiennent pas moins une quantité d'énergie importante. On a beaucoup étudié les vibrations sur l'axe vertical. Il ne faut pas cependant oublier que les excitations transversales soumettent le squelette, les ligaments et les muscles à un travail en cisaillement qui ne semble pas négligeable.

Une amélioration du siège dans le sens de la réduction de ces vibrations serait souhaitable.

Enfin la position du pilote est essentielle, en particulier la commande de pas cyclique qui oblige parfois le pilote à se pencher en avant et à gauche, en position dissymétrique.

Les hélicoptères ont toujours présenté des niveaux vibratoires élevés, il importe de remèdier en mieux à ce défaut afin d'accroître le confort des équipages et du personnel transporté. Il serait souhaitable que les dorsalgies et les troubles vertébraux ne constituent plus une des maladies profesionnelles des pilotes d'hélicoptère.

DISCUSSION

Maj. Gen. Evrard recalled that at Madrid in 1962 there had been a presentation emphasising the importance of seating position in various helicopter types; in some the posture of the pilot would clearly to likely to give rise to back pain. Dr Seris acknowledged the differences between them.

Wg Cdr Eley asked about the use of abdominal belts. He had tried the type issued to French helicopter pilots and found it very comfortable. Is their use mandatory in the French air force? Dr Seris replied that their use was voluntary. Their apparent effectiveness probably stemmed from the way in which they allowed the wearer to relax tension in the paravertebral muscles. He felt that it would be unwise to wear such belts on all flights, as muscle tone might be lost.

Wg Cdr Eley asked about vibration levels in the Sud 340 rigid rotor helicopter. Dr Seris replied that he had not yet had an opportunity to make measurements in this type.

Capt. Perry felt that most back troubles could be prevented by attention to seat and harness design. Dr Seris agreed. Brig. Gen. Lauschner expressed surprise at the quoted figure of 80% for back disorders. Was the incidence related to age? Dr Seris replied that in spite of early suggestions of a correlation it now appeared that the only group with a definitely enhanced susceptibility was those with a past history of back injury. There was considerable discussion on the value of X-ray examination to eliminate those with vertebral column abnormalities. Dr Seris stressed the value of such X-rays as 'controls' before a person undertook helicopter flying duties.

FATIGUE IN HELICOPTER AIRCREWS IN COMBAT

by

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RESUME

Etude de la fatigue des équipages d'hélicoptères au cours d'operations de combat au Vietnam. Cette étude est basée sur les observations personnelles de l'auteur, médecin de l'air, affecté à un bataillon aérien composé d'appareils à voiture tournante et intégré à une division de conception nouvelle quant à l'utilisation des hélicoptères et de l'infanterie.
L'étude comprendra le rôle de la mission, du milieu ambiant, des conditions de vie, de l'organisation des distractions, des motivations et du moral, dans la formation, la prévention et le traitement de la fatigue physique et émotionelle.

FATIGUE IN HELICOPTER AIRCREWS IN COMBAT

Captain J.T. Adams, US Army, MC

Material for discussion of combat conditions and related problems is largely based on experience and as such is rarely statistical in nature, except where compilations of experience are made. Material will, in the case of the individual, be confined within a circumscribed frame of reference. Extrapolations made from such information must therefore be general, and application qualified by realization that frames of reference are rarely identical. Nevertheless, analogies exist and may be relied upon to lend a broader perspective where future problems are to be anticipated.

The object of this discussion is to emphasize briefly not only the newer roles in which the helicopter is being cast in the military context, but to emphasize the requirements being placed in turn upon the aircrews. There is now available experience in protracted, purely helicopter operations. Application of past aircrew experience in fixed wing operations is limited, in my opinion, because of the differing employment of the two types of aircraft. It is generally felt by dual rated pilots that a higher level of physical coordination and attention, with less opportunity to relax, is required in helicopter flying.

The frame of reference within which these observations were made is as follows: The unit was battalion-sized, numbering approximately 550 men, of which approximately one third were pilots. The unit possessed utility helicopters, utilized in combat assault and combat support missions. The unit was part of an infantry division designed around the concept of air mobility. Under this concept troop movements, resupply and medical evacuation were accomplished by air as opposed to ground movement. The division possessed two such aviation battalions, plus a third equipped with medium cargo helicopters. These in turn provide virtually all transportation to three infantry brigades. During the initial operations it became evident that the utility helicopters were not capable of carrying projected loads and thus an additional factor was introduced, doubling aircraft requirements and flight times.

Nevertheless, this tactical design has proven practical and a second division is projected; therefore a greater number of rotary wing aviators will be exposed to similar conditions, and similar health problems, especially fatigue, will be encountered to the same degree.

The unit was based in a mountainous area, but conducted operations at low elevations as well. Climatic conditions ranged from subtropical to tropical, with seasons of high rainfall lasting several months. The performance of the helicopters was thus affected, in turn placing added stress upon aircrews.

Operations lasted from four days to four weeks or more, with intervals of three days to three weeks. The mission of the unit was to lift combat troops into hostile areas and maneuver them, at the same time providing logistical support, reconnaissance, and medical evacuation. Under such conditions aircrews flew from 8 to 12 or more hours daily throughout most operations. Excessive times were flown initially and as much as 35 to 40 hours flight time per individual accumulated in a 3-day period. Somewhat fewer hours were flown following the initial deployment of troops and supplies. Flight times averaged 80 to 100 hours monthly, not infrequently exceeding 130 hours. These aggregate times were flown under combat conditions, often at low level, wherein exposure to hostile fire was continuous.

Living conditions during operations were characterized by a continuous high-incident noise level produced by aircraft, generators, vehicles and artillery. Bivouac areas were generally secure. During the monsoon seasons clothing, bedding and tentage remained damp or wet in the field as well as base camp. Sleeping areas consisted of tents or helicopters, canvas cots or the ground. Meals were composed of C-rations or field mess rations in bivouac. Meals were rarely of high quality and occasionally of questionable palatability. This was a source of constant dissatisfaction.

Recreation was limited and consisted of voluntary efforts only. An active volley ball program was adopted in one company and provided considerable outlet. A difference in individual attitude and esprit was noticeable between this company and its confreres. Gambling, reading, letterwriting and drinking comprised the bulk of recreational activities. 'Rest and Recuperation' programs were utilized, but the number able to avail themselves of this was limited by the shortage of aircrews.

Aircrews were generally well motivated. Many of the pilots were quite young and had never flown in combat and this, coupled with the new tactical concepts under which they were required to fly, resulted in some confusion initially. The nature of the operations were such that goals were ill defined, difficult to set and thus sense of accomplishment never very high. In turn this was reflected in a morale level which fluctuated readily when compounded by additional stress.

Physical fatigue was a prominent outgrowth of these conditions and seen most often in older men. Long missions, irregular, inadequate and missed meals heightened the fatigue rate. Base camp labor details for self improvement while improving physical conditioning were usually conducted in addition to flying and served to increase physical fatigue. The high ambient temperatures, poor sleeping conditions and situational stress of prolonged combat flying in a demanding machine contributed to physical fatigue.

Aircrews tended to deny physical fatigue, making prevention and treatment more difficult. Prevention was predicated upon aggregate flight times recorded first by the month and later by the week. A chart was kept by the Flight Surgeon and posted in the Operations Center for perusal by the Battalion CO and Company Commanders. The elective grounding of aircrew members for prevention of fatigue was encouraged among commanders. This was reinforced by the Flight Surgeon when an individual was noted to be exceeding the acceptable limits or when gross fatigue symptoms were detected. Only with the Flight Surgeon's approval was a pilot allowed to exceed 25 hours weekly or 100 hours monthly. Precautionary grounding for fatigue consisted of 24 to 72 hours, depending on the tactical needs. Consequently, few cases of pure physical fatigue presented on sick call and these few were treated with grounding, light duty, and when necessary, hypnotics to induce better sleep.

Emotional fatigue was the more prevalent form of fatigue among aircrews and was seen principally in the younger age group. Individuals became irritable, arbitrary, uncooperative, argumentative, hostile or physically aggressive. Withdrawal, emotional lability and even hypomanic states were observed occasionally. Individuals were seen often on sick call with complaints of nervousness, insomnia, nausea, vomiting, abdominal discomfort or cramps, headaches, blurred vision, nonorganic paresthesias, tremor or weakness of psychophysiologic origin. Several requests for permanent grounding stemmed from emotional fatigue. Increased alcohol consumption was frequently employed as a means of coping with stress.

The more common stress factors which complicated emotional fatigue were the organic effect of anti-malarial drugs, climate, living conditions, hygiene, improper and prolonged utilization of aircraft for non-essential jobs, poor food, missed meals and mail, less than optimal aircraft maintenance, and the increased workload imposed upon an understrength unit.

Precipitating circumstances in cases of emotional fatigue consisted of family problems, marital disruption, peer conflict, loss of respect for authority, feelings of loss of support brought on by news from home, poor food, lack of mail. A few cases of moderately acute emotional fatigue were seen, each case precipitated by loss of a friend or injury of the individual. No acute depressions or psychoses were seen, and no evacuation or hospitalization required for emotional fatigue.

Prevention was difficult and measures consisted of early recognition based on close contact between the Flight Surgeon and pilots. Treatment was based primarily upon ventilation and support. Occasionally hypnotics were necessary, rarely short courses on one of the milder tranquilizers. No phenothiazines or MAO inhibitors were necessary and no significant amount of time was lost because of emotional fatigue. Several individuals were permanently grounded administratively and a latent fear of flying was suspect in some of these individuals.

In summary, emotional fatigue was more prevalent than physical fatigue, and both were present to a degree sufficient to warrant constant attention. Considering the prevalence of fatigue reactions and symptoms, it may be concluded that the preventive measures taken were justified and served to preclude even greater loss of time and possibly personnel, through severe illness, accident or combat loss.

I feel that the incidence of flying fatigue will be higher in purely rotary wing units engaged in tactical operations of the sort described. In order to recognize this, responsible personnel must be made aware of the problem and an active program initiated to seek out and recognize such problems before they reach the stage requiring prolonged treatment or hospitalization. When the pilot population is predominantly young, one should expect to see a higher incidence of emotional fatigue, disguised often as organic disease. Physical fatigue will be more prevalent in older age groups whose experience may protect them from emotional stress.

DISCUSSION

There was extensive discussion on the problems of measurement of fatigue and general dissatisfaction was expressed with both flying hours and number of sorties.

Capt. Adams emphasised that subjective assessment differed most significantly even between different flight surgeons. In reply to a question from **Capt. Ireland** he could not quote a significant relationship between fatigue assessment and accident rates although there was a strong impression that the two were related.

Wg Cdr Burton quoted the aircrew adage 'the more we fly - the more we want to fly'. He asked whether the value of gradual build-up of flying intensity had been assessed. **Capt. Adams** stated that for the unit on which he had reported this had been planned, but was operationally impossible. He agreed with the idea. **Col Malone** expressed the need for a basis of field clinical judgement rather than laboratory measures. He asked for opinions on the influence of motivation and 'command presence'. **Capt. Adams** agreed with the clinical approach and mentioned the importance of confidence which seemed to go with seniority and have a profound influence on anxiety.

Col Cody stated that in his experience field commanders were intensely aware of the fatigue problem and the importance of junior command standards of leadership. Senior officers generally flew considerably fewer hours. A first class relationship between Commander and Flight Surgeon was essential and he judged that observation by the Commander was an excellent mean' ' monitoring fatigue.

Maj. Aadahl asked whether raised alcohol consumption was a cause or effect of fatigue. **Capt. Adams** replied that he was unaware of a satisfactory means of differentiation.

Lt Cdr Williams stressed the vital importance of good instrumentation and autostablisation systems in reducing fatigue. Commando carrier practice was, where possible, to ferry crews back to the carrier after 24 hrs duty at a forward base in order to make the most of the infinitely better living, and resting, conditions on board.

Maj. Gen. Evrard asked about the official US Army policy on the use of hypnotics. **Lt Col Shamburek** replied that judgement was left to the Flight Surgeon in this field. **Brig. Gen. Lauschner** queried whether 24-72 hours grounding periods quoted by Capt Adams were long enough for recuperation. **Capt. Adams** replied that they often did not restore a man fully, but brought him back to an acceptable level of functional efficiency. Longer periods were operationally impossible.

Wg Cdr Eley expressed surprise at the ability of combat pilots to amass 130-140 hrs monthly over long periods. Was this in part made possible by the use of two pilots on all missions? **Capt. Adams** agreed that the second pilot helped, but **Capt. Ireland** remarked that in a US Navy study it had been found that co-pilots often became more tired than first pilots. **Lt Col Shamburek** stressed the value of the US Army policy of a one year limit on operational tours in Vietnam. This gave a man a definite target date to work on. He also mentioned that fatigue was often much worse in 'lift' helicopter crews than in 'gun-ship' pilots. The latter perhaps found an outlet for aggression which relieved their inner tensions, thus reducing at least one fatigue potentiating factor.

PROBLEMS OF TRAINING ARMY HELICOPTER PILOTS

by

Wg Cdr D.Eley, RAF

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RESUME

Introduction: Sélection des pilotes – conditions requises.

Données sur le Pilote: Expérience, formation, âge et grade.

Principes de l'Entraînement: Paramètres et méthodes.

Aperçu du Programme: Heures de vol et graduation de l'entraînement.

Problèmes Rencontrés aux Divers Stades:

(a) Vol Elémentaire – entraînement sur appareils à voilure fixe et entraînement de base sur appareils à voilure tournante (sous contrat civil).

(b) Entraînement Avancé sur Appareils à Voilure Tournante – entraînement avancé et tactique (militaire).

(c) Entraînement Avancé sur Appareils à Voilure Fixe – entraînement avancé et tactique (militaire).

(d) Tendances Futures – propositions de modifications du programme.

(e) Points Saillants d'Intérêt Général:

Age des Elèves
Désorientation
Vibrations et Fatigue
Dangers du Vol à Basse Altitude
L'élément humain.

Conclusion.

PROBLEMS OF TRAINING ARMY HELICOPTER PILOTS

Wg Cdr D.Eley, RAF

1. INTRODUCTION

The policy of the British Army is that its pilots should be first class soldiers with the extra skill and ability to fly functionally. This is reflected in the Selection system in that applicants are normally required to have had at least 3 years service in a Corps or Regiment prior to acceptance. After completing the normal RAF Aircrew Selection Tests and Medical examinations they are also required to attend a further Selection Board, which tests their military background and knowledge at the HQ Army Air Corps (AAC). Finally, the policy is justified by the specialised Army tasks that the man is required to perform such as observation and reconnaissance for all arms, artillery, observation and control, and forward air control for fighter ground attack, etc. After the completion of their training the majority of pilots return to their parent Corps or Regiment to fly with an Air Troop, where they will serve under the command of the CO of the particular Battalion, Artillery Regiment etc. This tour of duty will last 2 to 3 years, after which time they return to general regimental duties in the furtherance of their basic career. Obviously with 300 or 400 helicopters on its establishment and with a very small permanent cadre of the Army Air Corps there is a continual requirement to train in excess of 100 pilots per year.

2. PILOT MATERIAL

What of the students? They range in rank from Sergeant to Major, in age from 22 to 33 and differ widely also in their military background. Whereas some infantry and cavalry men are experts at map reading, signals operating and at giving orders, these capabilities might well be almost completely lacking in a student who comes from one of the Technical Corps or the Pay Corps, for instance. Naturally these latter are a minority and on a "good" course they are helped along by their more knowledgeable fellows. It is an interesting point that at the selection stage the NCO's failure rate is double that of the Officers, but during subsequent training there is little difference.

3. THE TRAINING POLICY

The training programme is based on the premise that there is no substitute for time in the air and also that a minimum of 180 hours flying is necessary before a pilot can be awarded his "wings". At a maximum acceptable rate of flying intensity this takes 31 weeks of training including one preliminary week of ground school. Whereas other countries, such as America and Canada train their helicopter pilots all through on

rotary wing aircraft, the British Army pilot's elementary stage of instruction is carried out on a light fixed wing aircraft, the Chipmunk, for the following reasons:

(a) It provides a stable platform for the acquisition of the basic skills and techniques of airmanship, navigation and radio operation.

(b) It helps in the early elimination of poor pilot material, providing a good test of co-ordination and judgement.

(c) It enables a student to master a simple flying machine at a fairly early stage, and to thereby gain adequate confidence in his ability in the air.

(d) The Chipmunk can be operated at approximately one third of the operating cost of a helicopter.

One further point to be clarified before discussing the training problems is that for reasons of economy and continuity both the elementary fixed wing and the basic rotary flying are carried out under civil contract.

4. SYLLABUS OUTLINE

The average 185 hours required to qualify are divided into three phases of instruction. The first 60 hours are spent in Elementary Flight using the Chipmunk and developing the basic art. The intermediate stage accounts for a further 60 hours and covers the initial introduction to helicopter handling. The final 65 hours are used to consolidate all previous training, introduce the student to the aircraft he will fly operationally and exercise him in its military uses. In Figure 1 can be seen the various stages of training and as I deal separately with the different phases I will highlight the various problems encountered, by the student.

5. PROBLEMS AT VARIOUS STAGES OF TRAINING

5.1 Elementary Flying

In the *Elementary Flight* the first 60 hours dual and solo flying is given, as stated, in the Chipmunk in a 10 week period. Approximately 10% fail to solo due to lack of aptitude. Other reasons for failure include persistent airsickness and other medical problems, some voluntary suspensions usually associated with lack of progress or disenchantment and a very small proportion fail the ground examinations. Nearly 90% of all failures occur in this initial phase. Experience has shown that if a student has difficulty in learning to fly the Chipmunk it is a fairly good indication that he will experience difficulty in the helicopter phase later. The converse is not necessarily true. The exercises covered include all the basic pre-solo exercises plus forced landings, low flying, navigation and map-reading, a few basic aerobatic manoeuvres and a little instrument and night flying.

In the *Basic Rotary Flight* after the completion of the Elementary phase the students fly their next 60 hours, also in a 10 week period, in the Hiller 12 B and C. Here the course may well be joined by a small number of experienced "fixed wing" pilots converting to rotary wing. All students, particularly the latter, find difficulty in using the left hand to manipulate the throttle and collective lever simultaneously to control the Rotor r.p.m. Confidence wanes at this point and morale drops and here a

further small percentage of failures occur due to the inability to reach the rotary wing solo standard. It is interesting to note that we have no experience whatsoever of airsickness among students in rotary wing aircraft.

During this phase all the basic helicopter flying exercises are covered and also a limited amount of instrument flying, night circuit flying and confined area work. Gradually throughout the phase both confidence and morale are restored.

5.2 Military Flying

Having now acquired a sound basic knowledge and skill the students commence their "applied flying" stage under military instructors. The aircraft used is the operational type which they will fly "in the field"; namely the Sioux or Bell 47G3 in Advanced Rotary Flight.

In the *Advanced Rotary Flight* the first 12 to 15 hours of dual and solo cover all the exercises previously flown in the Hiller. Most students cope adequately with this but some find the change from one type of helicopter to another very disturbing because of the difference in the position, feel, movement and response of the controls. Following this part, which is really a type-conversion course, the remaining 45 to 48 hours are devoted to applied or tactical flying. This consists of mountain flying, underslung load handling, tactical flying, day and night cross country flights, observation and reconnaissance, artillery control, forward air control, etc. In the final part of the course the students are taken out on movement exercises with their aircraft, fuel and other logistics and are required to move across country, night-stopping in the field and taking part in simulated manoeuvres. This is the culminating period of their training and incorporates all the various skills and techniques which they have been taught. At this time one or two students reach a mental saturation point. They could cope with the pure flying, but when faced with the need to map read, work the signals net and carry out a task at the same time they find it all too much. This is a kind of "channel loading" where given a sufficient number of separate problems simultaneously the mind eventually rejects everything.

After successfully completing this last 10 weeks phase the graduates gain their "wings". They then go on to their respective theatres of operation where, after 20 hours of theatre training, they join their Air Troops as competent Sioux pilots.

Some ten to fifteen per cent are selected, however, to fly Scout helicopters with Brigade or Division Flights. These pilots undergo a five week post-graduate course which is, in reality, a turbine aircraft conversion with the addition of General Purpose Machine-Gun (GPMG) firing. Most students find the Scout easier and smoother to fly but because it is more complicated and sophisticated they have to cover extra technical work in the classroom. Also if and when an emergency occurs their reactions must be very fast.

Advanced Fixed Wing Flight. Following an extensive change-over from fixed to rotary wing aircraft the small remaining fixed wing contingent of Beaver aircraft has left only a minimal pilot requirement of 8 to 9 a year. In order to provide these pilots in future, experienced pilots who have completed a tour of rotary wing flying will be selected for Beaver training. This will include about 30 hours refresher and advanced training on the Chipmunk followed by 80 hours on the Beaver. In addition to this

commitment, a 30 hours course of airway and instrument flying training will be given to Beaver pilots due to be posted to the European theatre. Finally a two week Territorial and Army Volunteer Reserve refresher course will be given to a few ex-service pilots.

Future Trends. Some of the known problems of training Army Pilots have been highlighted in this short talk outlining the syllabus adopted by the School of Army Aviation. Within the coming 12 months several important changes are to be made to bring them in line with changing requirements. More helicopter flying will be introduced at the expense of fixed wing flying, i.e., 145 hours helicopter and 40 hours fixed wing. The replacement for the Hiller it is hoped might be the Bell G5 giving an easier step to the Sioux, but the total length of the course will remain at about 31 weeks and the total hours 180-5 hours.

5.3 Salient Points of Interest

Having covered the various phases of the course and the student problems that they raise I now propose to touch briefly on some general points of interest.

Student's Age. In Figure 2 can be seen the influence of starting age on a student's chances of success. Up to approximately 29 years old his prospects improve, but over this age they deteriorate rapidly. Over the age of 32 years the odds are weighted heavily against him learning to become a safe and effective Army Pilot.

Disorientation. As most of the flying is done at medium or low level little difficulty is experienced with disorientation. However, at night with a very limited instrument panel, several cases have been reported of disorientation due to rain or mist obscuring all or part of the bubble canopy. Another cause is movement of lights reflected on the bubble surface or the flickering of navigation lights and anti-collision beacons reflecting off the rotor blades.

Vibration and Fatigue. The noise vibration and mental strain when flying a helicopter is probably comparable with that of a high speed jet. I have discovered that my instructors and students alike tend to fall asleep for half an hour or so when they get home in the evening.

Low Flying Hazards. High tension cables are one of the most formidable hazards to a low flying machine. Bad visibility has been a contributory factor in some cases, usually coupled with an over-zealous sense of urgency or a temptation to "get home regardless". In other cases the wires and/or pylons were made invisible by the setting or rising sun or the pylons were buried in trees on the slopes and the wires were slung across the valley between. A warning device is now in an advanced stage of development; it is capable of providing a warning at ranges up to 800 yds of live 50/60 cycle power cables. This will not relieve the pilot of the need to look out but it will help to put him on his guard. We have had some interesting discussions on rate of scan, blank spots and the risk of deception by optical illusions. One recent incident occurred when an experienced flying instructor flew a Chipmunk through the top of a low 30-40 ft tree standing in a beech hedge of only 10-15 ft but lost against a background of similar trees. It was winter and they were leafless. Neither the instructor nor the student in the front cockpit saw this tree until they hit it.

The Human Element. An important factor which must not be overlooked is that flying instruction in the air is a one-to-one relationship which depends above all on the personalities of the instructor and his student. Whereas certain general statements can be made, the human being is such a complex creation and is subject to so many variable factors, that success or failure cannot be accurately forecast nor results analyzed statistically with any great accuracy. Success will depend largely on the understanding, co-operation and flexibility of the two persons concerned. Factors such as "motivation" and "personal adjustment" should be carefully considered. Sometimes a slow starter with limited aptitude but with patience and dogged determination, given the extra time and guidance eventually becomes a safer and more effective pilot than one with aptitude and speed of uptake.

Most students' mental processes are dulled in the air and again the degree of this can vary largely from one to the next. With time and experience this effect becomes less but is sometimes the cause of suspensions.

Above all, any undue pressure or personal anxiety can easily slow up a student's rate of learning and therefore everything possible should be done to learn about the cause of worry in order that it may be eliminated if possible. A good instructor should know his students well and adopt his approach accordingly.

Age, rank, title or experience of the world are of little assistance on a flying course. In fact it often works in reverse sense, for flying training is a great leveller and unless the student puts his pride in his pocket he soon falls from his high perch.

6. CONCLUSION

As most of you here today are pilots you will already be familiar with many of the problems that I have mentioned. Few of them are new or even peculiar to helicopter training. However, it is important that they are remembered and borne in mind in any studies or discussions of this kind.

The discussion following this paper appears on page 187.

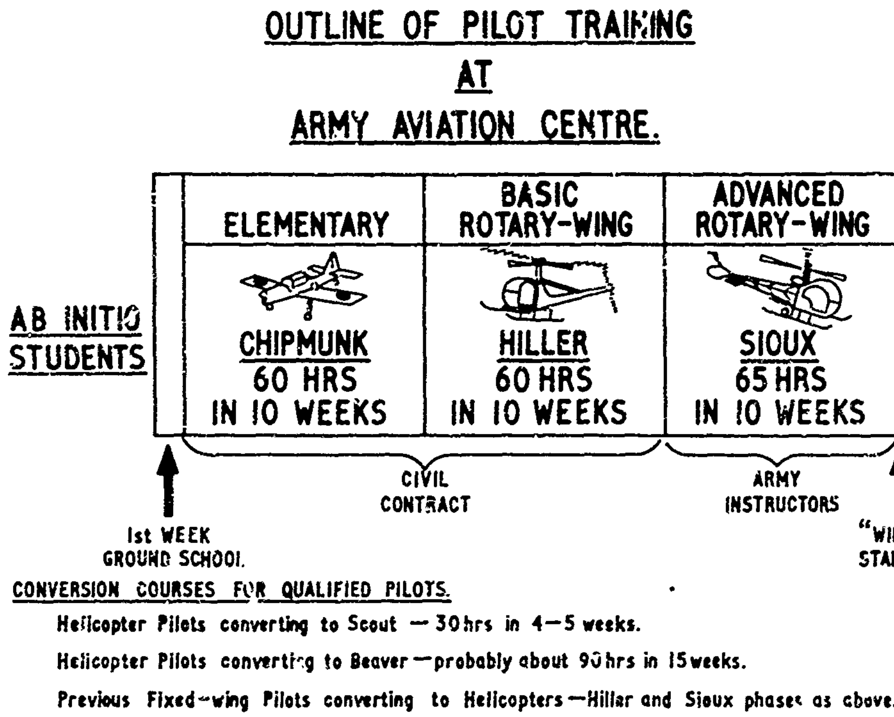

Fig. 1 The training scheme

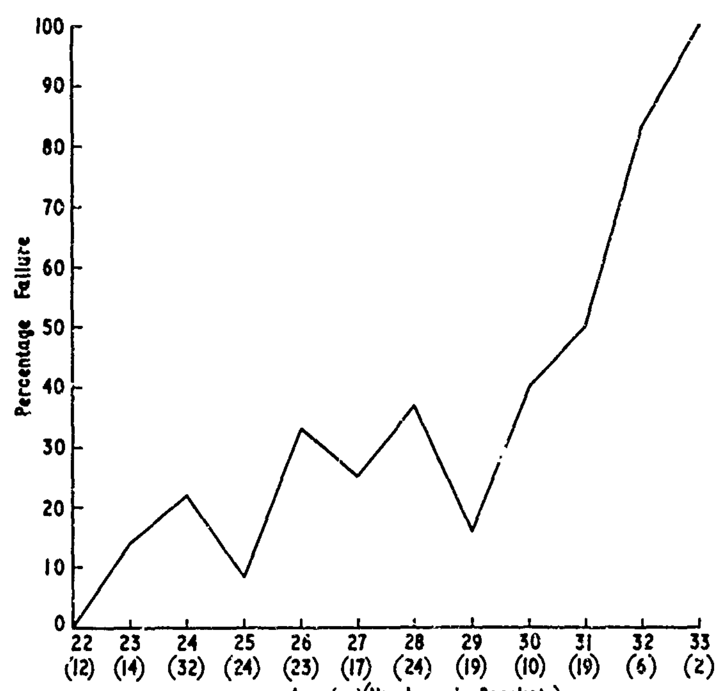

Fig. 2 Percentage failure rate by age of students. Army Aviation Centre - Helicopter Pilot Courses. July 1964 - December 1966

DISCUSSION

Col Hoogvliet expressed surprise at the number of flying hours thought necessary. The Netherlands Air Force accomplished its training in less time (80 hours) although it must be conceded that all trainees were fully qualified fixed-wing pilots. He asked whether the speaker agreed that jet-turbine powered helicopters like the Alouette, with no throttle control on the collective pitch lever were easier to train crews on. He also enquired about British policy on autorotative descent training and single pilot operation. **Wg Cdr Eley** acknowledged the advantages of training on turbine-powered machines, but this was not possible with current British equipment, only the more sophisticated types of helicopter being thus powered. In the training given in the United Kingdom tremendous stress was placed on engine-out training and subsequent periodic checks of engine-out skill in qualified pilots. Single pilot operation was an integral part of British practice.

Col Hoogvliet asked for other opinions on the concept of omission of engine-out training from the syllabus. **Mr Bruggink** commented that at one stage this had been discontinued because more aircraft were lost in practice than in actual engine-out conditions. However, the result had been markedly increased severity in the accidental autorotative descents, due to lack of skill. **Lt Cdr Williams** stated that the Royal Navy, like the other British services, laid great stress on engine-out training.

Cdr Mackie asked the speaker about the value of instrument flying training on the Hiller primary trainer. **Wg Cdr Eley** replied that, with a few added instruments, two hours per pupil was found a valuable introduction to instrument flight in helicopters.

Col Cody asked whether the speaker could compare pupil-instructor relationships during the civil contract and service instructor phases of training. **Wg Cdr Eley** thought that they were quite comparable, probably because the civilian instructors were, in fact, all ex-service. He stressed that he felt it vital to maintain a good pupil/instructor relationship during training.

SUMMARY OF SESSION III

by Brigadier General Lauschner

During the session devoted to Aircrew Problems in Helicopter Operations special attention has been given to the noise problem and to certain aspects of toxicology such as measurement of very low concentrations of dangerous, toxic or even potentially hazardous substances in the cockpit.

Vision as a problem in helicopter operation was discussed very interestingly, the speaker pointing out the necessity of correct interpretation of all visual cues available and the importance of the angle of vision. Another problem area is that of vibration which was demonstrated in some aspects by preliminary reports on a prototype and by clinical findings. Surprisingly high was the percentage of helicopter pilots complaining of pains in the spinal region.

The development, the characteristics and the importance of fatigue with special reference to a flying unit under combat conditions provided an insight in practical approaches to reduce or to solve problems or at least to cope with a given situation. A valuable account of experience in the training of helicopter pilots with a discussion of the training methods and programmes gave the opportunity to compare different approaches and to improve existing methods, stimulating more work on the human element in helicopter flying.

ICING AND THE RESCUE HELICOPTER

by

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RESUME

Un hélicoptère tous-temps apte aux opérations de sauvetage militaires ou civiles doit être capable d'effectuer des vols prolongés et sûrs en conditions de givrage.

Les hélicoptères non munis de dispositifs protecteurs sont soumis à des limitations très strictes lorsqu'il s'agit d'effectuer des vols sûrs à travers des couches nuageuses extrêmement froides. Le danger de givrage consitute actuellement l'un des principaux handicaps affectant le fonctionnement opérationnel des hélicoptères.

L'hélicoptère est sujet au givrage du moteur et du rotor, givrage qui peut le placer dans une situation dangereuse.

L'étude de ce problème a nécessité la réalisation d'une installation où l'on peut soumettre les hélicoptères à des essais de givrage dans des conditions de sécurité raisonnables à la fois pour le personnel et l'équipement.

L'auteur décrit l'installation d'essais de givrage par vaporisation du National Research Council à Ottawa et présent les résultats de plus de dix ans de recherches et de développements dans le domaine des systèmes de dégivrage et d'anti-givrage d'hélicoptères.

ICING AND THE RESCUE HELICOPTER

T.R. Ringer, J.R. Stallabrass, R.D. Price

1. INTRODUCTION

The rescue helicopter must be an all-weather aircraft if it is to fulfil its role. In Canada we have a wide range of environmental conditions with hot humid weather around the Great Lakes in the summer and extremely cold dry conditions in the northern regions during winter. One of the more severe environmental conditions for all aircraft and in particular for helicopters is icing.

2. NATURAL ICING

Aircraft icing occurs when the aircraft enters an atmosphere containing supercooled water droplets. When the frontal areas of the aircraft strike these droplets which are at a temperature below freezing, the impact upsets the metastable supercooled state and ice forms, adhering strongly to the surface.

2.1 Temperature

When moist air is cooled below its saturation temperature, the water vapour will, in the presence of condensation nuclei, condense to form a cloud of minute water droplets. If the air is cooled still further it is found that these water droplets do not freeze spontaneously until supercooled well below the equilibrium freezing temperature of water. In the absence of freezing nuclei in the atmosphere, the supercooling required for such homogeneous freezing is about 40°C. Ice-forming nuclei occur naturally in the atmosphere but are rare (in the order of one per litre) compared with condensation nuclei which occur in hundreds per cubic centimetre (Ref. 1).

In theory, aircraft icing may occur at any temperature between 0°C and -40°C; in practice, however, the probability of ever encountering icing of any significant severity below about -30°C is exceedingly small. This probability is illustrated in Figure 1 which expresses the probability that for a given icing encounter the temperature will be less than the value indicated. It may be seen that over 90% of all icing encounters take place at temperatures above -20°C. This probability plot does not take into account the severity of the icing encounter, which must take into consideration not only the temperature but also the liquid water content of the atmosphere.

2.2 Liquid Water Content and Extent

The liquid water content expresses the concentration by weight of liquid water in a unit volume of space. The usual unit employed is grams per cubic metre. The amount

of water condensed is a function of the initial humidity of the air and the degree of cooling. Thus the liquid water content of layer type clouds in temperate latitudes is fairly low, but the extent of the icing cloud may exceed a hundred miles. In tropical latitudes where the initial humidity is high and where thermal upcurrents may carry this moist air aloft some tens of thousands of feet to form large cumulonimbus clouds, liquid water contents may be very large (in excess of 5 gm/m^3), but the horizontal extent is fairly limited. Figure 2 shows the exceedance probability for liquid water content while Figure 3 relates liquid water content to horizontal extent.

2.3 Droplet Size

There is a tendency for larger droplets to occur in cumuloform clouds than in layer clouds, but no very marked correlation exists between droplet size and liquid water content. In general, a diameter of 20 microns is accepted as typical for the purposes of design of icing protection systems. Actual diameters* range from about 10 microns to 50 microns or larger.

2.4 Types of Ice Formation

The ice that forms on any forward-facing surface of an aircraft is often classified by its appearance and characteristic shape. The usual classifications are:-

(a) Glaze Ice. Glaze ice is characterized by its shiny surface and transparency, and grows in a double-horn or mushroom formation. It occurs at high temperatures or with high water concentrations, and because not all the water freezes immediately on impact, some of it runs back and freezes on either side of the leading edge to form the characteristic double horns.

(b) Intermediate or "Glime" Ice. This is a form intermediate between glaze and rime ice. It has a milky appearance and a shiny surface.

(c) Rime Ice. Rime ice is characteristic of low temperatures and low water concentrations. It has a white, almost frost-like appearance, and grows with a sharp leading edge.

All three forms of ice may occur simultaneously at different stations along a helicopter rotor blade owing to the velocity variation with radius, and the resultant variation in aerodynamic heating with span.

3. SIMULATION OF ICING

3.1 Icing Wind Tunnels

To carry out any systematic study of the nature and effects of aircraft icing and to permit the rapid evaluation of various design features in a de-icing system, it is essential to be able to simulate and control in the laboratory the conditions conducive to icing. This is most easily done in a wind tunnel, but not a conventional wind

* The diameters quoted are volume median diameters, i.e. half the volume of water in a given sample is contained in drops larger than the quoted value, and half in drops smaller.

tunnel because the air needs to be at a temperature below the freezing point of water, and into it minute water droplets have to be introduced to simulate an icing cloud.

The cold air may be produced either naturally or by refrigeration. The refrigerated icing wind tunnel is a closed-circuit wind tunnel, in which the air is continuously recirculated. At one point in its circuit the air passes through a cooling heat exchanger to maintain it at the desired temperature. This type of tunnel has the advantage of being independent of ambient temperature, thus permitting year-round operation and independent control of tunnel air temperature. Being closed-circuit, such a tunnel may be designed to simulate altitude (low pressure) conditions. Its disadvantages are greater complexity and installation cost (including a large refrigeration plant).

In either type of wind tunnel an icing cloud has to be produced. This is achieved by placing ahead of the test section an array of water spray nozzles. These spray nozzles are usually of the air atomizing type of a design that produces a droplet size distribution representative of a natural icing cloud.

Figure 4 illustrates N.R.C.'s high speed icing wind tunnel. This is an artificially refrigerated closed-circuit wind tunnel having altitude capability. Its leading particulars are.-

Airspeed:	0-1000 ft/sec (Mach 0.9)
Altitude:	0-30,000 ft
Temperature:	Down to $-40^{o}C$
Liquid Water Content:	0-2.0 gm/m^3
Droplet size:	15-40 microns
Test Section:	12 in. x 12 in.

A naturally cooled icing wind tunnel requires that it is located geographically in a region which receives an appreciable number of below-freezing days during the year, so that the tunnel's utilization for icing purposes is not unreasonably small. Locations such as Canada and certain upland regions of Europe and the United States are suitable for such tunnels. Naturally cooled tunnels are invariably of the open-circuit type in which the cold atmospheric air is induced in one end, and exhausted again to atmosphere at the other. This type of tunnel has the advantage of simplicity and cheapness, but has the disadvantage that no independent control of the air temperature is possible.

4. HELICOPTER ICING SIMULATION

While an icing wind tunnel is a useful device for the investigation of airfoil, engine inlet, windscreen and instrument icing, the size of working section required to handle even the smallest helicopter precludes it as an economic method of investigating helicopter icing.

If we consider an open-circuit icing wind tunnel we depend on nature to supply the refrigeration. If we depend also on natural air velocity to move the cold air we can dispense with almost all of the usual components and in fact all we require is a cloud forming mechanism.

In 1953 the National Research Council undertook to investigate the effects of icing on helicopter flight performance and a simulation facility was developed for this purpose. Figure 5 shows the helicopter spray rig located at Uplands Airport in Ottawa.

The spray rig consists of a welded steel framework supporting the spray nozzle array, the steam and water supply and drain headers in addition to the necessary instrumentation. 161 steam atomized water nozzles are used to form the cloud which is approximately 70 feet wide and 15 feet deep. The spray rig frame may be raised to a height of 60 feet on a supporting mast and rotated to take advantage of any wind direction.

The spray rig requires a water flow of up to 6000 pounds per hour with a corresponding steam flow of 80,000 pounds per hour. Icing cloud conditions of up to 0.9 grams per cubic meter liquid water content with a droplet size range of 20 to 60 microns diameter can be simulated.

The spray rig is limited to use between 15 November and 15 March because of available temperatures in the Ottawa region. We require a minimum airspeed of 5 m.p.h. to move the cloud from the rig to a hovering helicopter.

Since construction of this facility we have had helicopters in from France, the UK and the US for investigations.

5. ICING OF HELICOPTERS

The main rotor blades may accumulate ice to cover 10% of the chord on the upper and 25% of the chord on the lower surface. The spanwise extent can vary with temperature.

The tail rotor blades also accumulate ice; however, the deposit is usually symmetrical about the leading edge.

The high airflows required by today's turbine engines result in high deposition rates of ice at the entry to the engine. Build-up rates of ¼ in. per minute in moderate icing conditions are a frequent occurrence.

Ice will also build up rapidly on the inlet guide vanes ahead of the first compressor stage. This ice will limit the airflow into the engine, thereby reducing the amount of power available from the engine. A further effect of this ice build-up is the possibility of the ice breaking away and being ingested by the engine resulting in severe damage to the compressor section, which may require the engine to be shut down, or in the case of a single-engined helicopter, an emergency landing.

6. METHODS OF PROTECTION OF HELICOPTERS

6.1 Thermal

Hot Gas. The availability of quantities of hot gas from turbine engines led to the investigation of using this hot gas to prevent ice from forming on the rotor blades. Unfortunately the high heat loss suffered in distributing this gas to the rotor tip required the temperature of the incoming gas at the root of the blade to be in excess of the structural limitations.

6.2 Electrical

Heater Pads. Two types of heater pads are presently available – one a woven wire embedded in a plastic insulator, the other a sprayed metal element also covered by plastic. The heater pads are placed on the rotor blades such as to cover the main icing area of the blade, i.e. 10% upper and 25% lower. The pads are usually divided into six heated strips, each ¾ in. wide and connected to a common ground return. The heated strips are sequenced so that the strip on the leading edge of the blade is heated first, followed by the adjacent one above, then below, until the full complement of heater strips has been energized. This sequencing reduces the amount of instantaneous power required from the generators to shed the ice off the blades. The heater pad on the tail rotor usually comprises one or at the most two heater strips and these are energized in conjunction with the main rotor blades. The entire de-icing system less generator usually weights about 90 lbs.

6.3 Chemical De-icing

Chemical de-icing appears attractive for many reasons; first the low weight of the system when not carrying full tanks of fluid, its simplicity in hardware, and its low first cost.

The system comprises a fluid tank, usually of a capacity to give one hour's protection in icing conditions; a fluid pump which pumps the fluid from the tank to a distributor at the top of the rotor mast. From the distributor the fluid then feeds into a series of tubes feeding each rotor blade. A duct running the full length of the rotor blade has a series of holes drilled through from the leading edge. This allows the fluid to flow through the holes and spread along the surface of the blade leading edge.

The disadvantage of the fluid system is the weight penalty with full fluid tanks. This frequently exceeds that of the electrical system and is also duration limited. A small helicopter requires between 50 and 80 lbs. of fluid and a medium sized helicopter about 250 lbs. of fluid to give the necessary one hour's ice protection.

A reciprocating engine only requires carburetor heat to prevent ice from forming on the throttle value.

The gas turbine engine, however, requires much more elaborate ice protection. The I.G.V.'s and front bearing support struts are fed by hot gas from the compressor section, while the engine inlet is covered with a woven wire heater mat which is designed to prevent ice from forming at all times.

7. CONCLUSION

Whether one uses electrical or chemical icing protection is a secondary consideration. That some form of icing protection is required for the rescue helicopter should be in no doubt.

A recent publication in "Canadian Aviation" for March 1967 emphasizes this point. A number of ice-fishermen were stranded on a breakaway ice floe on Lake Simcoe, north

of Toronto. A rescue operation was set up using an Aeronca Champ. Helicopters were called in to assist. One was unable to get off the ground because of icing. The second encountered severe icing conditions on the journey to the rescue site and one door was removed in flight to give better visibility.

Once on the ground at the rescue site the helicopter accumulated additional ice and could not be flown.

The next day when weather conditions had improved, the remaining ice fishermen were picked up by helicopter.

DISCUSSION

Capt Mattox asked about the distribution of ice formation on rotor blades. **Mr Ringer** replied that this was a complex matter, but generally ice tended to accumulate towards the tip in very cold conditions and towards the hub in more moderate conditions.
Brig Gen Lauschner asked whether anti-icing pastes were of use in helicopter operations. **Mr Ringer** replied that their value was very limited in degree and duration of protection.

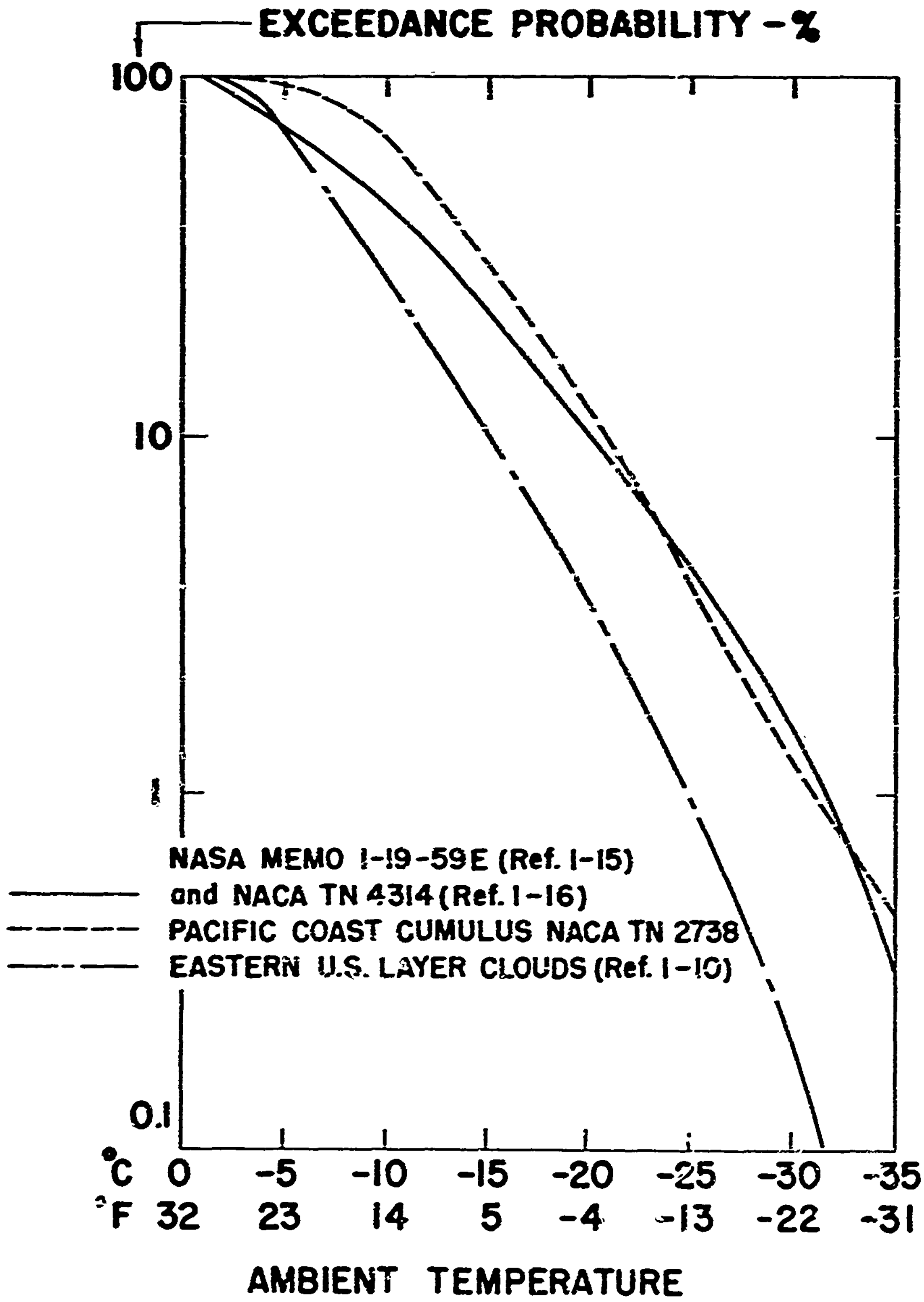

Fig. 1 Probability of cloud icing temperature

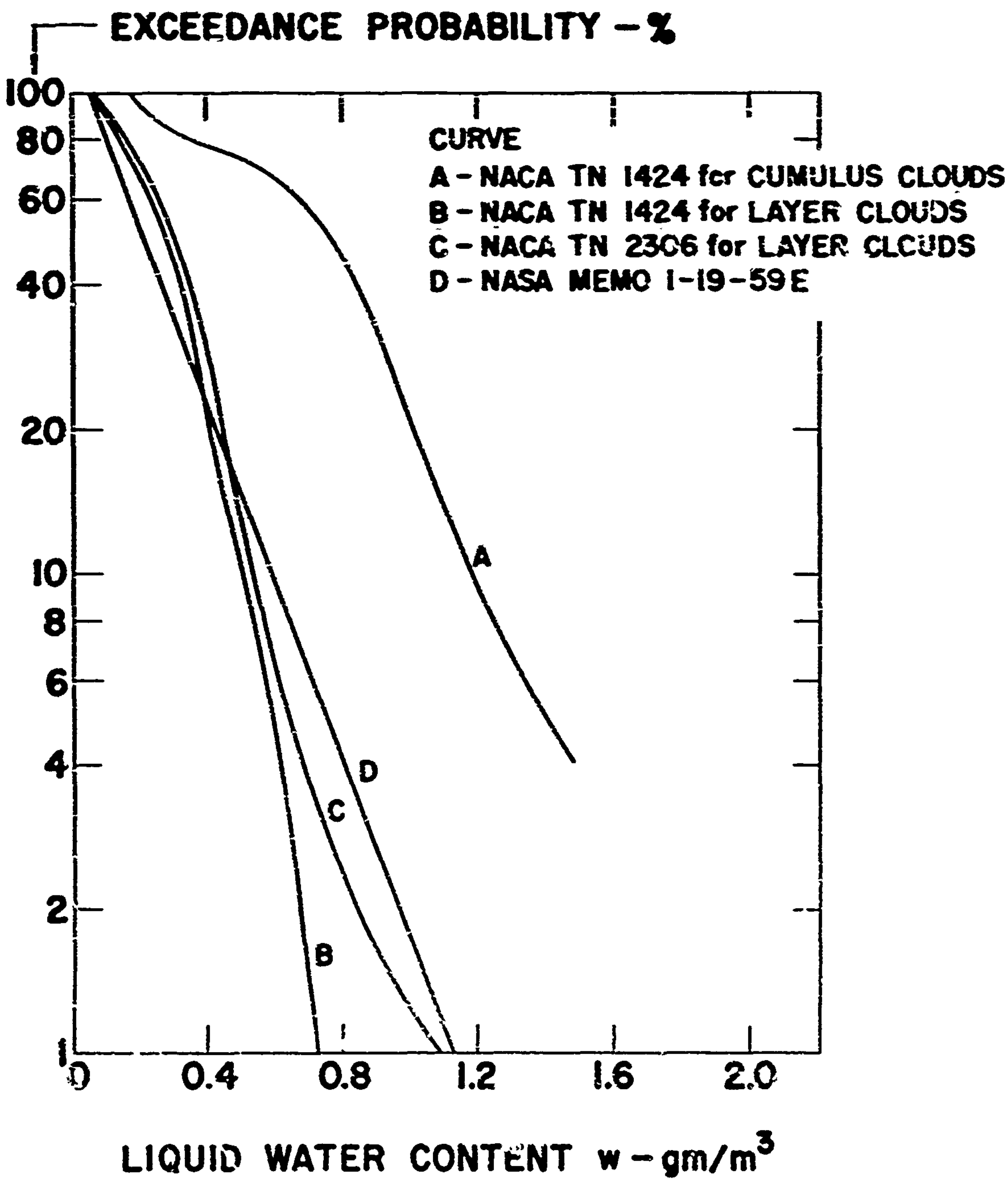

Fig 2 Exceedance probability for liquid water content

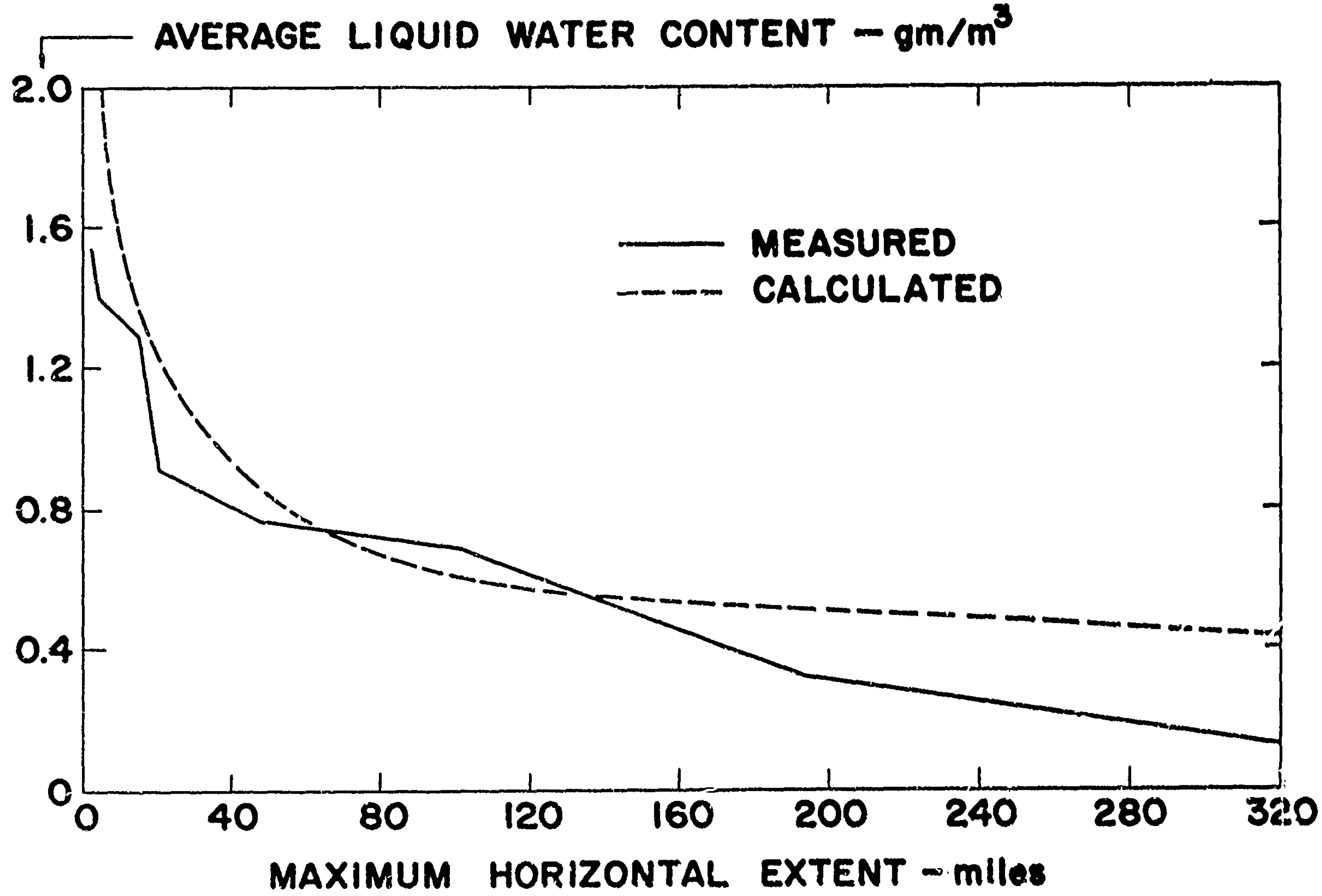

Fig. 3 Liquid water content versus horizontal extent

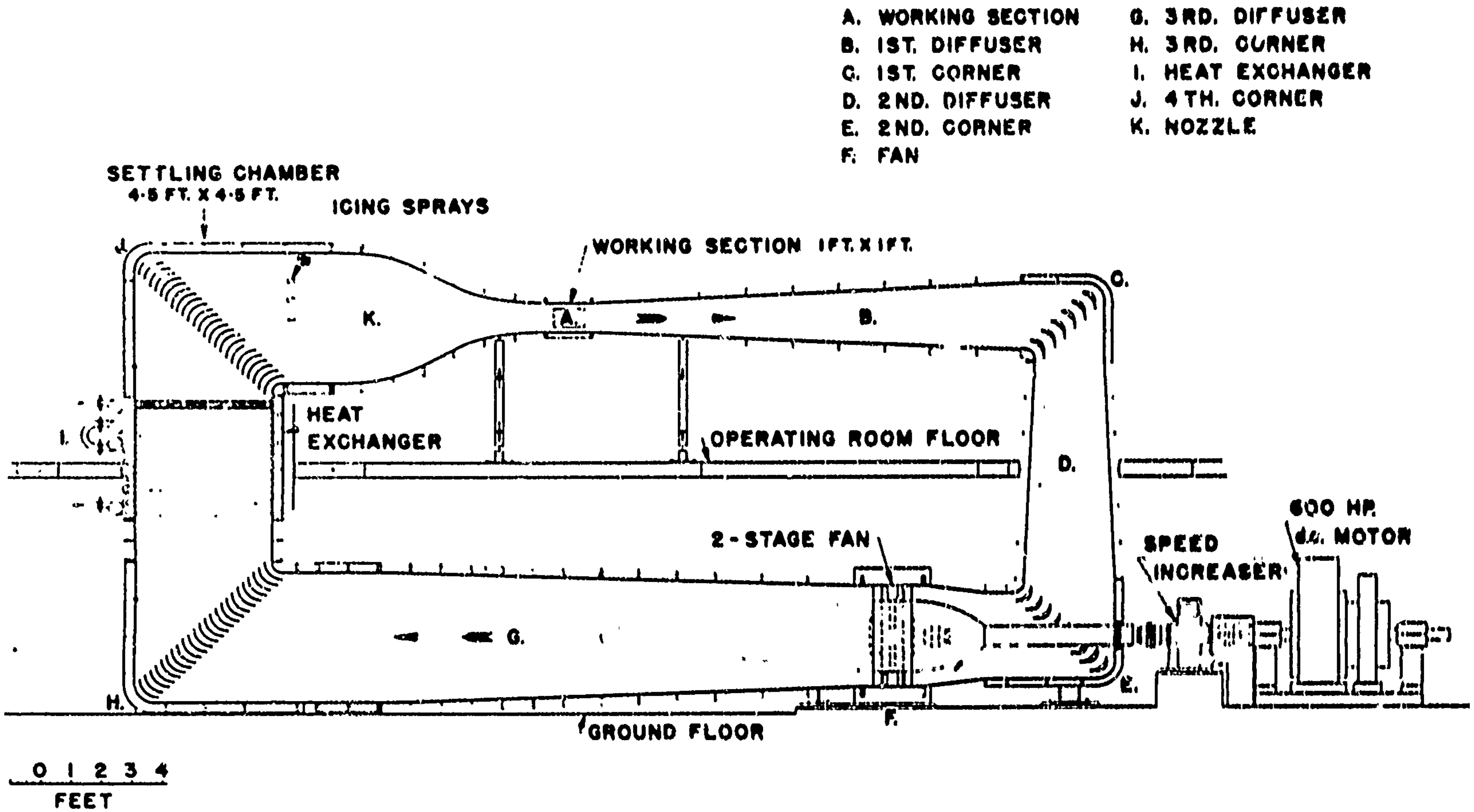

Fig. 4 High speed icing wind tunnel

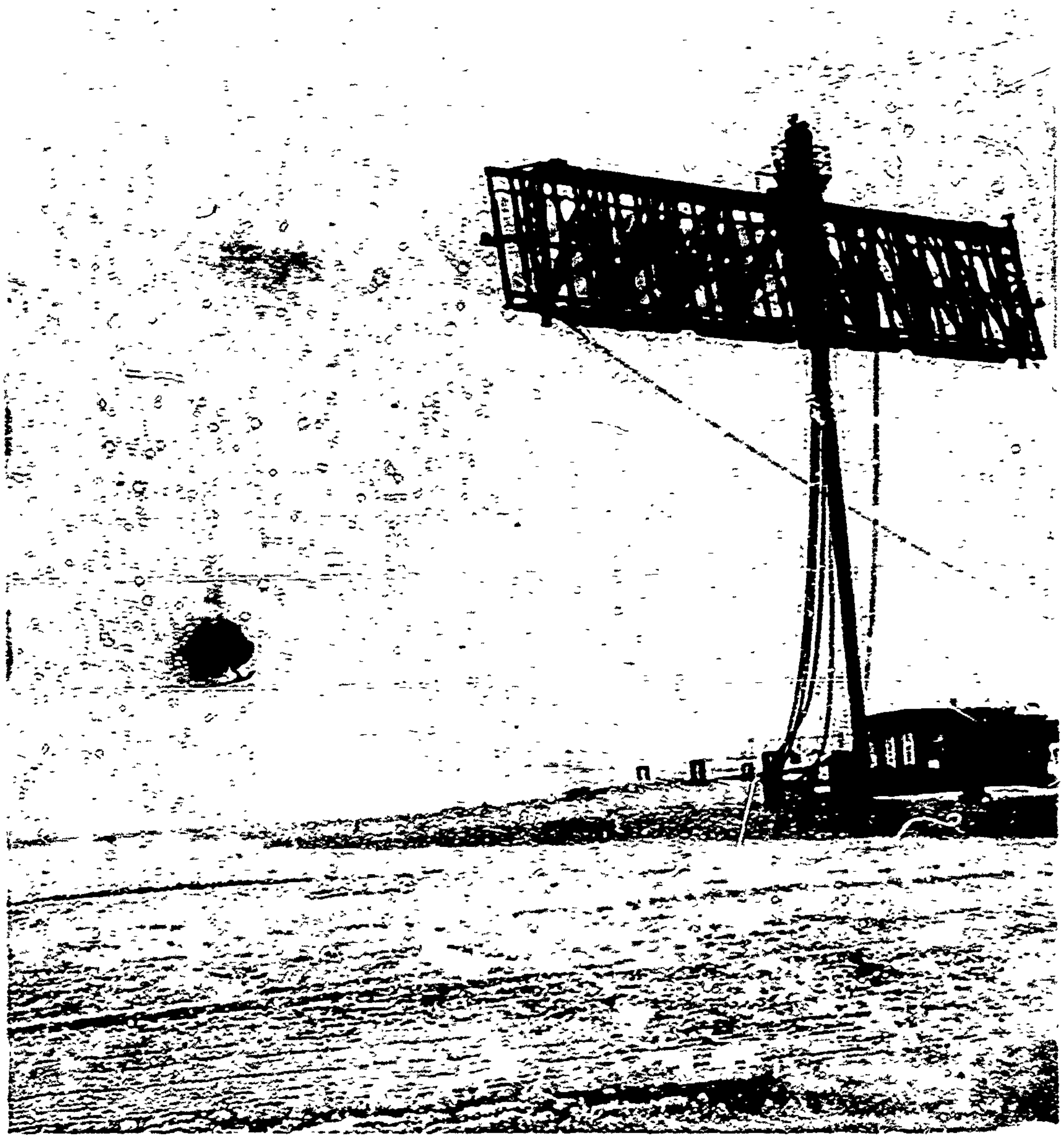

Fig. 5 The helicopter spray rig at Uplands, Ottawa

HAZARDS OF OVERWATER HELICOPTER OPERATIONS

by

Surgeon Commander I.H. Colley, RN

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Yeovilton, Somerset, UK

RESUME

L'auteur fera le bilan de l'expérience acquise par la Marine Royale Britannique dans le domaine des risques présentés par les opérations en hélicoptère au dessus de l'eau; il décrira ensuite les méthodes de formation adoptées pour aider les équipages à abandonner un hélicoptère submergé.

HAZARDS OF OVERWATER HELICOPTER OPERATIONS

Surgeon Commander I.H. Colley, RN

INTRODUCTION

"Hazards of Overwater Helicopter Operations" is too grand a title for what I propose to outline in the short time at my disposal. The major hazard is, of course, escape after ditching, and it may be of interest and value to state simply how we have tried to improve what was a very poor chance of survival by the institution of a training programme.

UNDERWATER ESCAPE TRAINING

Like all services operating helicopters over water, we have come to know by experience the areas in which difficulties lie in escaping from a submerging aircraft when all crew members and passengers are devoid of any form of breathing apparatus. But, as you can guess, this absence of a respirable atmosphere has proved to be one of our lesser problems. Possibly the most important one to overcome has been the impact on the escapee of disorientation, closely followed by the absence of underwater vision and consequent difficulty in identifying escape exits, and the risk of bodily injury associated with being thrown around against hard metal when unstrapped. (There has never been a problem about flotation because of the universal use of a Life Saving Waistcoat.)

Our first attempts at training all Helicopter aircrew in underwater escape were aimed at demonstrating the great ease of onset of spatial disorientation occurring when devoid of underwater vision, or in the dark. A simple canvas screen was manufactured enclosing 3 feet of water in the shallow end of a swimming bath, and having standard escape hatch windows fitted to it: this enabled trainees to take a breath, submerge, be spun around by an instructor to induce disorientation, and then try to climb out through the escape hatch. This was, to say the least, a salutory experience. This simple device was good as far as it went, and culminated in pupils escaping when blindfolded. But no account was taken of swirling water, and the essential need to wait until water entry was complete before starting to escape. In late 1959 a more realistic helicopter "dunker" was built, and finally in 1962 a fully sophisticated Whirlwind rear cabin was installed in a deep tank at Portsmouth. With the added safety of underwater lighting, and the extra comfort of heated water, a comprehensive training period is now undertaken by all helicopter aircrew, and repeated mandatorily every 2 years. It is a training programme which is enjoyed retrospectively, and has received unanimous praise from all who have later required to escape in earnest. It is possible also, that it has had a not inconsiderable part to play in increasing chances of survival.

A short series of photographs will best illustrate this current Royal Naval training procedure.

Fig.1 This illustrates the dunker, a mock-up Whirlwind rear cabin which can be fitted out with several different seating arrangements. The cabin is attached to a deep tank (12 foot of water) at the after end by geared spindle, and suspended at the forward end by a gantry crane. In the horizontal position shown here the cabin is a few inches clear of th water. On the side of the cabin shown you can see the forward door and the after escape taped window. On the other side there are two windows, one with a handle and the other taped.

Figs.2 and 3 show the dunker being swung out ready for the run. You can see the seat alongside the after window which the trainee occupies for his first training run.

Fig.4 Here the run has started with 45° of rotation and some sink being achieved.

Fig.5 This is 90° of rotation. You can see the escape handle on the aircraft - the pupil is seated by this after window.

Fig.6 At 130° the pupil's head is about to go under water.

Fig.7 shows the final position from which the escape is made as soon as water swirling has ceased.

The sinkage time is only 10 seconds and is related approximately to actuality. The trainee's head however does not enter the water until the final few seconds of sinking. The average time of head immersion is only 5 seconds. Several of these runs are carried out by each trainee, culminating in dual runs escaping through various hatches and/or the most difficult of all - the door. Very thorough and personalised briefings are given by the supervising officer who is a helicopter observer and trained Ship's Diver, and safety devices are stationed strategically in the tank and inside the cabin. Emergency hoisting can take place almost instantaneously.

No hard and fast "do this; don't do that" rules are laid down, because no two ditchings are ever the same. Possibly the most important lesson learnt by the pupil is to remain strapped in his seat harness until the main inrush of water has settled, thus avoiding being swept away and losing the position of the escape hatch. No matter how disorientated the victim becomes - as long as he waits for motion to cease, he can guarantee that his escape hatch is still in the same position relative to him. At the worst, he is in a better position to use the guide rails to his exit panel.

In summary, we can claim success in this venture from the laudatory comments we receive from our pupils - and, most important of all, comparing the experiences of our survivors before and after the institution of this now well established training routine.

The discussion following this paper appears on page 211.

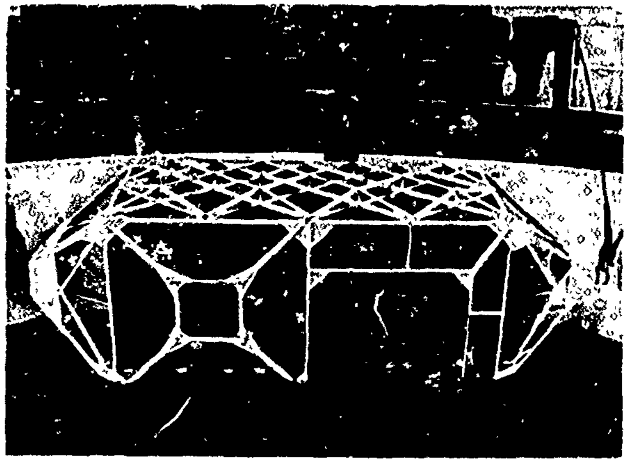


Figure 1

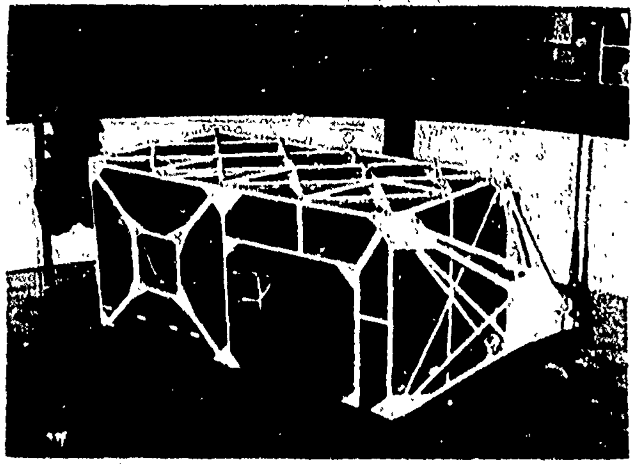


Figure 2

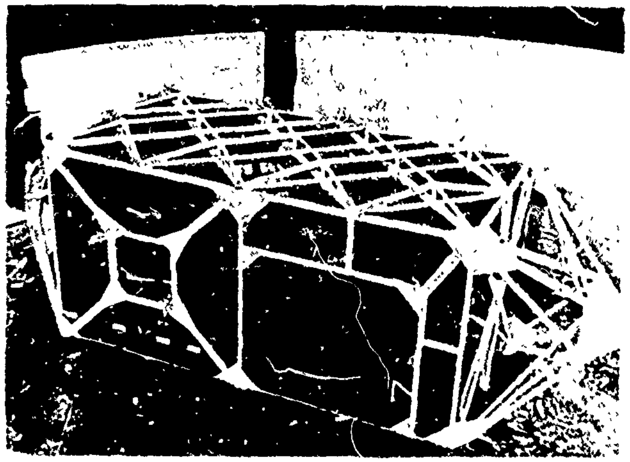


Figure 3

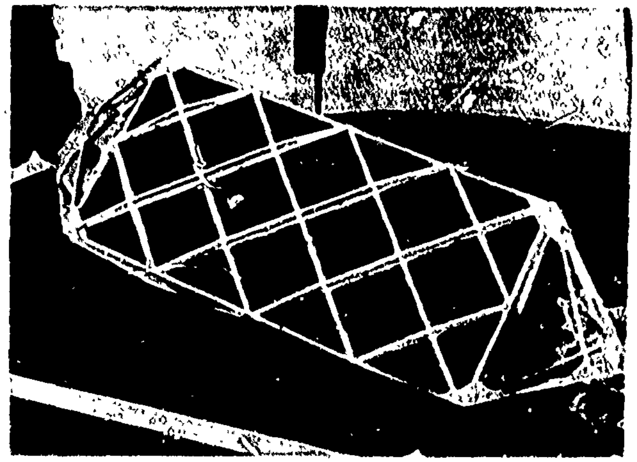
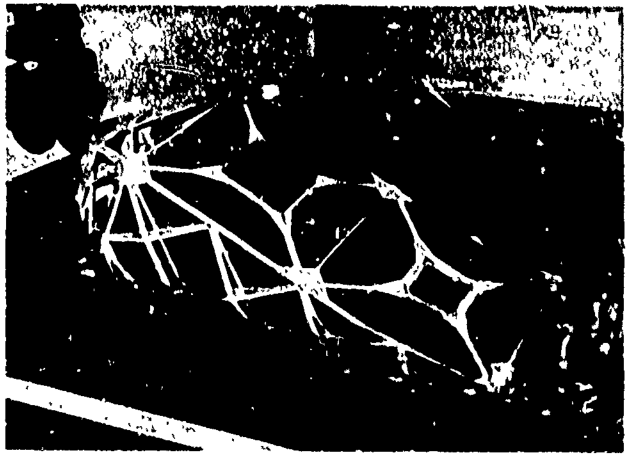
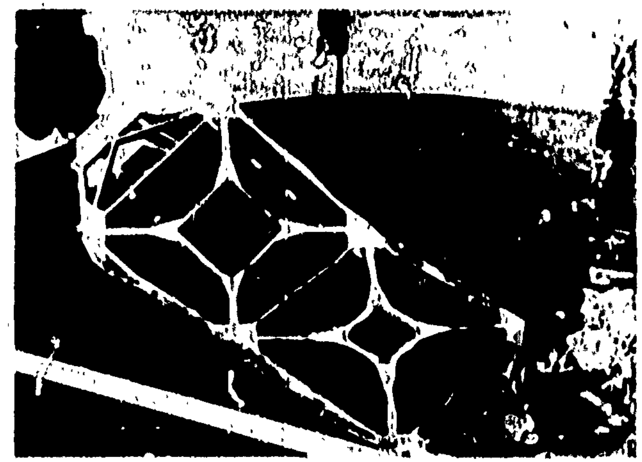


Figure 4



Figuro 5



Figuro 0

Figuro 7

DISCUSSION

Lt Cdr Williams endorsed the value of 'dunking' training and emphasised that the training device need only be an approximation to any particular helicopter configuration. Since training had been introduced ditching deaths had been virtually limited to those injured on impact.

Mr Bruggink commented that in US Army experience a big problem was training crews and passengers to remain in helicopters in land accidents until the rotor had stopped turning. He asked about stability of ditched helicopters. Cdr Colley replied that their flotation characteristics was very variable.

Cdr Mackie gave a brief account of two recent accidents to RN Wessex helicopters. The first suffered a power loss at 60 ft, 30 kts. On impact one hub flotation bag burst and the helicopter consequently rotated into the inverted attitude. The diver on board fractured his leg in the impact. The crewman escaped unhurt. In the second incident, which occurred under virtually identical conditions, the pilot exercised much better control via the collective pitch lever and achieved a very gentle 'splash'. All buoyance bags inflated and the craft floated with water at the door-sill level. The tail bag broke after 5-6 minutes. The main problem was persuading the pilot to leave the water – thirty minutes later he was still in the sea trying to fix a lifting line on his aircraft! Lt Cdr Williams stated that in his experience the rotating main rotor blades had never proved a hazard to escape on ditching.

A HELICOPTER PERSONNEL ESCAPE, PROTECTION AND SURVIVAL SYSTEM

by

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RESUME

La Marine des Etats-Unis a récemment démontré qu'une "capsule fuselage" destinée à sauver les occupants d'un hélicoptère à la suite d'avaries en vol était techniquement réalisable. Elle l'a prouvé grâce à des essais en vol d'un système installé sur hélicoptère télé-commandé. Ces développements ont été entrepris à la suite d'une étude de la Marine sur les accidents graves et mortels, dont il est ressorti que 56% des blessures mortelles auraient pu être évitées grâce à un système d'abandon d'appareil en vol, et 25% de ce cas mortels ainsi que la majorité des blessures graves, si d'autres moyens de protection - contre l'incendie ou l'impact - ou des dispositifs de flottaison avaient été disponibles.

L'auteur exposera les aspects techniques et médicaux du programme mené par la Marine des Etats-Unis pour metere au point un système complet capable d'assurer la survie des occupants d'hélicoptères. L'élément essentiel de ce système sera la "capsule-fuselage" composée de dispositifs pyrotechniques destinés à larguer les pales de rotor et les parties étrangères du fuselage, et de parachutes à déploiement balistique servant à assurer la récupération de la partie occupée du fuselage. Des siège amortisseurs, des dispositifs d'absorption d'énergie, de prévention et de lutte contre l'incendie, montés sur l'hélicoptère, feront également partie intégrante du système.

A HELICOPTER PERSONNEL ESCAPE, PROTECTION AND SURVIVAL SYSTEM

Since the early days of military flying, methods for in-flight escape from disabled aircraft have been considered and developed, keeping pace with the improved performance and the increasingly hazardous missions of the combat aircraft. These methods range from personal parachutes and early ejection seats through fully automatic ejection seats to the recent sophisticated escape capsule system installed in the F-111 aircraft.

The sole exception to this progressive development is the helicopter. During development of the helicopter, no special provision for in-flight escape from helicopters has been seriously considered. This probably has been due to the following factors:

1. The autorotational capability of the helicopter, permitting power-off, steep gradient spot landings, instills pilot confidence in his ability to cope with in-flight emergency situations.

2. Mistrust of the effectiveness of personnel parachutes, because the unstable nature of the aircraft and the close proximity of the whirling rotor blades would hinder egress and preclude successful bailout during helicopter in-flight emergency situations.

3. The low altitudes flown as compared to fixed-wing operations. (This may be both a cause and effect of the above. For example, lack of parachutes encourages low flying to permit quick landing in the event of trouble; low flying rules out the use of personnel parachutes. In addition, of course, certain missions demand low altitude flight.)

4. The inconvenience of wearing a parachute.

5. The complexity and weight of ejection seats coupled with the problem of avoiding the rotor blades during ejection.

In Southeast Asia the helicopter has "come of age" as a combat vehicle. It has established its worth as an extremely important and integral part of limited war combat operations by its successful employment in close-in attack and patrol missions, vertical envelopment operations and in dramatic rescue operations in hostile territory. However, these types of missions have naturally led to increased exposure to enemy attack by ground fire to which, because of the low and slow flight profiles, the helicopter is particularly vulnerable. Compared to personnel flying fixed wing aircraft on similar close-in support missions, the helicopter aircrew have virtually no survival protection.

THE IN-FLIGHT ESCAPE PROBLEM

By virtue of changes in missions, the autorotative maneuver is becoming less reliable as a means to neutralize the personnel hazards associated with in-flight emergencies, particularly at low altitudes. Successful autorotation requires hundreds of feet of altitude to ensure sufficient lift from the rotors and a visual ground reference to select suitable landing terrain and accomplish the flair maneuver to arrest the rate of descent just prior to touchdown. But the requirement for increased speed and higher payload capability has necessitated advanced blade design and resulted in higher blade loadings, both of which dictate an increase in the altitude required for accomplishment of the autorotative maneuver. This increased altitude required for autorotation is in direct opposition to the low altitude flight profiles being flown. As the helicopter has become a combat vehicle, battle damage to the critical parts, (i.e., blades, transmission, etc.) required for successful autorotation is highly probable. These factors combine to make very hazardous reliance on autorotation as the sole means of combating an in-flight emergency.

THE ADDITIONAL SURVIVAL PROBLEM

Helicopters do not afford adequate protection from crash impacts, fires or ditchings. The crew seats are designed for 10 g and troop seats designed for less. The armor protection hurriedly added as a result of early combat losses to protect the occupant from ground fire may actually reduce his capability to survive a crash because the added weight of armor, accomplished without a commensurate strengthening of the seat support structure, has reduced the impact "g" tolerance of the seat by approximately one half. The present configuration of fuel cells is inadequate. While the cells have a self sealing capacity in the lower portions, they are vulnerable to Armor Piercing Incendiary and tracer ammunition in the upper vapor zone. The existing cells installed are easily ruptured by crash impacts and having no means of fire suppression, are susceptible to both in-flight and post crash fires.

Personnel surviving a helicopter emergency do so only when the crash impact is light, post crash fires small, or the helicopter floats for a sufficient time to permit the occupant to escape; survival is *NOT* due to helicopter design. Advanced personnel safety and survival aids, required to ensure injury-free survival during emergency situations, have not substantially influenced helicopter design. It has been concluded that helicopters do not provide an acceptable level of injury-free survival during either in-flight or crash emergencies.

The proposed Helicopter Personnel Escape Protection and Survival System will respond to this operational deficiency by providing the required capability for high survivability for personnel which does not exist in any present operational helicopter.

THE INITIAL STUDY

Realizing that the foregoing was true, the US Navy, in 1961, contracted for a study of helicopter accidents to document the helicopter accident picture and to provide data to guide the design of means to prevent fatal and critical injuries during helicopter accidents[1]*. From an analysis of the data on Navy helicopter accidents for the

*Numerical superscripts designate references at end of paper.

period 1952-1960, the study revealed that 90% of in-flight emergencies occurred at altitudes between 100 and 600 feet above terrain (Fig. 1) and demonstrated the urgent need for an escape system which would function at these low altitudes. It was concluded that the escape system must provide safe in-flight escape following an emergency occurring as low as 100 feet for maximum "save" capability. Based upon this 100 foot minimum altitude, it was estimated that 56% of the occupant fatalities (Fig. 2) could have survived by the use of an advanced type of in-flight escape system. An additional 25% of the fatalities were estimated to be "candidates for survival" by the use of improved crash safety and survival provisions such as: Impact protection; Crash-fire prevention and Emergency flotation.

The following three methods of in-flight escape were examined during the study from the aspects of performance, weight and effect on airframe design.

1. Individual parachute and normal bailout.

2. Rotatable crew ejection seats with horizontal ejection to clear rotor blades.

3. Capsule escape system.

Individual parachutes were rejected as not offering the escape performance required. Ejectable crew seats, while they would provide the best in-flight escape performance under most conditions, were rejected because of the weight penalty and prohibitive airframe design complication when trying to save occupants of a multi-crew/passenger vehicle.

The capsule escape system was selected as the lightest, best performing and most efficient means of providing in-flight escape. The capsule also affords two additional meaningful benefits:

1. The passengers play a completely passive role and need do nothing to ensure their survival, and

2. The required crash protective and survival features can be more easily integrated into the "system" design, as applied to the complete helicopter.

A minimum escape performance altitude of 100 feet in hovering flight was determined to be feasible based in part upon advancements in pyrotechnic initiation and severence devices, but primarily upon the recent development of Ultra-Fast Opening Parachutes. These parachutes are ballistically deployed and ballistically spread and, therefore, their response is rapid and their performance relatively independent of airspeed. The parachutes can be spread fully in static conditions.

TEST PROTOTYPE CAPSULE SYSTEM DESIGN

Based upon the results of this initial study, the Navy set out to conclusively prove the feasibility of the capsule escape system. In this project, a capsule escape system was developed for and installed in obsolete UH-25B helicopter test vehicles configured for remote controlled flight for full scale system testing. The feasibility of the escape capsule system was proven by three successful in-flight initiations of the system during March - June 1966. The details of the development of the overall system and of the recovery subsystem are included elsewhere[2, 3].

The UH-25B system installation is shown schematically in Figure 3. During the drone tests (Fig. 4) the system was initiated from the single source and the explosive energy was transferred by Confined Detonating Cord (CDC) simultaneously to initiate the rotor blade jettisoning and the fuselage severence devices (Fig. 5). It is specifically emphasized that these assemblies were structurally intact (no disconnects) and were severed by Linear Shaped Charge and other explosive devices. Separation rockets were ignited to insure rapid, positive jettisoning of the unoccupied rear section from the inhabited portion or capsule and the rotor blades departed the area (Fig. 6). After a 0.6 second delay to ensure a clear area, four 35 foot diameter parachutes were ballistically deployed (Fig. 7) and ballistically spread (Fig. 8) to recover the capsule (Figs. 9 and 10)

CAPSULE FEASIBILITY TEST PROGRAM SUMMARY

Four drone tests were conducted and the system was successfully initiated in three. The initial test attempted was aborted due to drone control difficulties. The following is a summary of the results of each test. Detailed results are recorded elsewhere[2].

Test Number 2 - conducted on March 31, 1966, was completely successful as shown in Figures 4 through 10. This test was historic as the first in-flight severence of a structurally intact fuselage and recovery of a fuselage capsule. The helicopter was flying straight and level at a ground speed of 53 knots at initiation. All subsystems and components functioned correctly and the capsule was recovered by the parachutes, at a survivable rate of descent of 31 feet per second, 74 feet below the point of initiation. The sequence from initiation to recovery required only 2.7 seconds. The capsule impacted on external energy attenuators (trusgrid honeycomb absorber pads) at a level of 35 g.

Figure 11 compares the oscillograph traces of this impact with two traces from previously conducted controlled crashes of helicopters without the energy absorbers at approximately the same impact velocity. The absorbers were very effective and attenuated the impact from an expected level of greater than 150 g to 35 g and greatly reduced the all important "g" onset rate and eliminated "g" rebound. This great reduction in impact loads due to the pads made further attenuation to acceptable physiological tolerances within the capability of energy absorbing troop seats. The experimental troop seat having energy attenuating capabilities shown in Figure 12 was installed in the capsule and functioned properly to reduce the impact on the 225 lb anthropomorphic dummy to a survivable 20 g.

Test Number 3 was also successful but a very interesting malfunction occurred. The system was initiated with the helicopter in a 40° dive and at a ground speed of 26 knots in order to demonstrate the capability of the separation rockets to provide clean separation between the jettisoned aft fuselage section and the capsule under dive conditions. Attainment of a survivable rate of descent of 45 feet per second was accomplished 143 feet below the system initiation altitude. The forward rotor blades failed to jettison but were stopped by the parachute risers. Though the risers were shortened by being wrapped around the blades little or no effect in recovery system performance was noted. The capsule impacted at 32 feet per second and the impact forces were similar to those recorded on Test Number 2.

Test Number 4 repeated the previous successes but another very informative malfunction occurred. The helicopter was flying at 90 knots ground speed in a shallow dive at system initiation. Recovery to a survivable rate of descent was achieved at 187 feet below the system initiation point. A riser on one of the parachutes was severed by a test fixture and the parachute was lost. However, the capsule impacted at 34 feet per second with results similar to those noted on tests Numbers 2 and 3.

Tests Numbers 1 and 5 were test failures as the system was not initiated. Drone control problems during Test Number 1 resulted in a crash of the helicopter on takeoff prior to initiation of the system test. The helicopter was purposely crashed on Test 5 after vain attempts to initiate the capsule system.

In summary, it can be concluded that the program was successful and much useful information was learned from the failures.

The results of Tests Numbers 2, 3, and 4 proved conclusively that the capsule system could function successfully under varying helicopter flight conditions.

The ability of the system to provide successful recovery within 100 feet from level or hovering flight was demonstrated.

The tests also demonstrated that impact forces can be attenuated to within physiological tolerances by use of external energy absorption devices and energy attenuating seats functioning in harmony with each other.

The failure of the rotor blade to jettison during Test 3 was traced to faulty CDC leads, so also was the failure to initiate the system on Test 5. These failures demonstrated the sensitivity of the CDC leads to rough handling and indicated that additional protection of these leads must ' provided in an operational installation.

The safety and insensitivity of the pyrotechnic devices during a crash was demonstrated during Tests 1 and 5. Severe impacts, resulting in massive structural damage to the helicopter, did not cause detonation of any pyrotechnic devices.

The rotor blade jettison failure was informative since this proved that the ballistic deployment of the parachutes was so rapid that catastrophic parachute failure was precluded. It also demonstrated the recovery system's relative insensitivity to interference by the blades.

Survivable rate of descent with only three of the four parachutes inflated was demonstrated.

THE FUTURE PROGRAM

The US Navy, supported by the US Army technical personnel and numerous private contractors, is embarked upon a program to design and develop a "Helicopter Escape, Protective and Survival System" toward operational use in helicopters.

To ensure the validity of the system approach selected on the basis of the study of accidents occurring during the 1952-1960 period, a similar study is being completed

of all Navy and Army accidents through 1965. Some preliminary results of the study of the latest Navy data combined with the earlier data are presented in Figure 13. It can be seen that the updated statistics continue to support the requirement for means to provide in-flight escape and crash-safety provisions for helicopter occupants.

The program objective is to protect future helicopter occupants from fatal and incapacitating critical injuries despite the nature and severity of the emergency. This will be accomplished by the design of a true "system" through close integration of the various required features so that they function in harmony with each other. The "heart" of this system is the escape capsule but the protective and survival features are an inseparable part of the system as illustrated in Figure 14.

The following sequence is presented: to illustrate the composition of the Helicopter Personnel Escape, Protective and Survival System and how it would function in operational use. The system is illustrated pictorially in Figure 15 as it would apply to a large troop carrying turbine powered helicopter.

Upon recognition of the emergency, the pilot (or other crewman if the pilot is incapacitated) will initiate the system by a single action that actuates the initiation subsystem.

The initiation subsystem, composed of either; detonators and Confined Detonating Cord (CDC) or a laser and fiber optic transfer network will trigger the severance, separation and recovery subsystems automatically in the proper time sequence.

The severance subsystem, composed of Linear Shaped Charge, (LSC) explosive bolts and explosively driven guillotines, will simultaneously cut the fuselage, jettison rotor blade assemblies, fuel tanks, and engine pods, as required.

The separation subsystem, composed of rockets and/or thrusters, will impart a separation velocity between the fuselage (aft section, fuel tanks, engine pods, etc., as required).

The recovery subsystem, composed of parachutes which are ballistically-deployed and ballistically-spread and of retrorockets, (used in the case of large recovered payloads) will be actuated after a time delay to ensure that the jettisoned portions are clear.

The parachutes will be rapidly deployed and spread, to reduce quickly the capsule's velocity to a survivable rate of descent, or to a velocity which can be reduced to a survivable rate of descent, by the retro-rocket when sed. The retro-rockets, used in combination with the parachutes to obtain the most efficient recovery system from weight and volume standpoints, will be initiated just prior to ground impact by a mechanical, explosive or avionic ground sensing device.

It is at this point in the escape from an in-flight emergency situation that the protection/survival devices enumerated in Figure 14 come into play.

External energy attenuation (EA) devices in the landing gear and mounted on/in the fuselage operate mechanically to reduce partially the shock of the impact on the occupants. The effectiveness of these devices was shown previously in Figure 11.

Energy attenuating seats (Fig. 12), protective apparel and restraint devices, working in concert with the external EA devices, reduce the impact shock to an acceptable human tolerance level, provide restraint for the occupants and protect their heads to ensure an injury-free impact.

In the event there are on-board fuel tanks, fire preventive measures (emulsified fuel and/or impenetrable fuel tanks) and fire suppressive measures (extinguishing by the automatic injection of foam or inert gas into the tanks) will preclude post-impact fires.

Automatic flotation devices and/or built-in capsule waterweight integrity will ensure capsule bouyancy following water impact.

Survival equipment will be available to ensure long-term survival should such be required.

The protective/survival features, described above will greatly reduce the incidence of fatal and incapacitating critical injuries during emergencies initially occurring in the area below 100 feet and, therefore, beyond the capability of the in-flight escape system.

Helicopter and personnel armor have not been mentioned in this discussion but, while it does not function as a direct part of the escape capsule, it is of course an integrated part of the total "Helicopter Personnel Escape, Protection and Survival System" as it offers protection against the most hazardous and real threat to personnel survival in combat.

SYSTEM DEVELOPMENT STATUS

The reader should be quickly oriented to the state-of-development of the Helicopter Personnel Escape, Protective and Survival System and its various components. The system is actually an integration of many devices which have been under development for some years or are in operational use.

All of the subsystems/devices shown in Figure 14 are in an advanced development status with two exceptions; the recovery system and the latest fire prevention and extinguishing devices adaptable for the system application.

Exploratory development is currently underway by the US Army laboratories and civilian aircraft agencies to obtain automatic fire suppressive devices. Inert gas injection and instant foam devices are being investigated. Also, much work has been and is being accomplished in the area of decreasing the fuel fire hazard by use of gelled and emulsified fuels.

The application of ballistic deployment and ballistic spreading to parachutes up to 72 feet in diameter has been completed and extensive developmental testing accomplished[4]. However, based upon the test results to date, increased efforts must be expeditiously undertaken to decrease the operating time of these parachutes and to match their maximum deployment speed capability with the ever-increasing speeds of the latest helicopters.

Retro-rockets have been developed for a multitude of applications but are not in operational use. It is of maximum importance, in order to obtain the most efficient and lightest recovery system, that a retro-rocket system be developed for the helicopter capsule application and tested to ensure that high reliability will attained from both the sensing device and the rockets. By use of retro-rockets a very important benefit will be obtained. If the recovery system can be devised to position quickly the capsule into the retro-fire attitude, the retro-rockets will provide a great amount of impact attenuation, even though the recovery parachutes have insufficient altitude to function completely. In this manner, the "no man's land" where neither the capsule nor the protective devices would be effective, estimated to be 40 feet to 100 feet above the terrain, can be eliminated.

SYSTEM IMPACT ON HELICOPTER AIRFRAME DESIGN

This paper would not be complete without a discussion regarding the effect of the "Helicopter Personnel, Escape, Protective and Survival System" installation on the helicopter airframe configuration and gross weight.

The system installation will not require major modifications to the airframe. The capsule subsystems, with the exception of the recovery subsystem, will be composed of small, lightweight components dispersed evenly throughout the airframe. A cursory examination of the current helicopters has shown that existing voids will permit satisfactory installation of the recovery system and that the other capsule components can be easily accommodated.

The protective and survival devices can also be installed with a minimum of structural change because the largest components (i.e., energy attenuating seats and landing gear) will be replacements for currently installed items.

Thus, the preliminary conclusion has been made that, not only is the Helicopter Protection, Escape and Survival System adaptable to the majority of US helicopter designs but that retrofit is possible if certain design considerations are accepted.

Weight added to a helicopter is of course a prime consideration in the installation of any system. Unfortunately, as helicopters in most cases do not have even so much as a parachute installed for personnel survival, a weight penalty will result from the installation of the system. Preliminary weight estimates indicate that the complete system will increase the gross weight by 6-8 percent. The actual increase in gross weight is dependent upon several factors, such as weight of the helicopter, number of passengers, amount of structure which can be jettisoned and the type of recovery system used. The system weight is also influenced by a decision as to the acceptance of a higher recovery system weight in order to recover the complete fuselage and thus enabling the helicopter to be returned to service after minor repair. A reduction in recovery system weight can be achieved on the order of 40 percent by use of a hybrid system of parachutes and retro-rockets in lieu of an all-parachute recovery system.

The final determination as to whether or not the increase in helicopter gross weight, due to installation of the system, can be tolerated must be made on a systems effectiveness basis.

Is the degradation in mission effectiveness, by virtue of the added weight, offset by the gains in aircrew safety, in terms of personnel saved, which will result from installation of the system?

Based upon the accident data, projected into future helicopter operations, it is estimated that the escape capsule will provide the bulk of the "saves" (60-65%) as it will insure injury-free survival when initiated at 100 feet in hovering flight, at lower altitudes with forward speed present, and will perform throughout the ever-increasing speed regime of the helicopter. The balance (35-40%) of these saves will result from the ability of the Protective and Survival Group to reduce the fatalities and critical injuries now occurring during crashes by attenuation of the impact "g" levels to within human tolerance and by eliminating post-crash fires and drownings.

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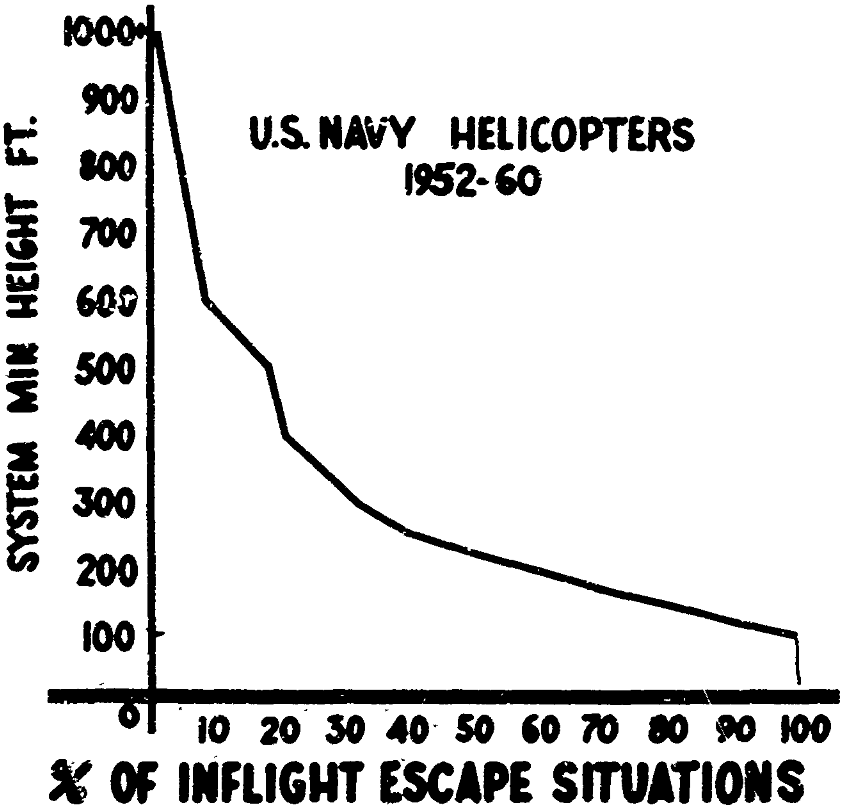

Fig. 1 Escape system capability versus potential number of escapes

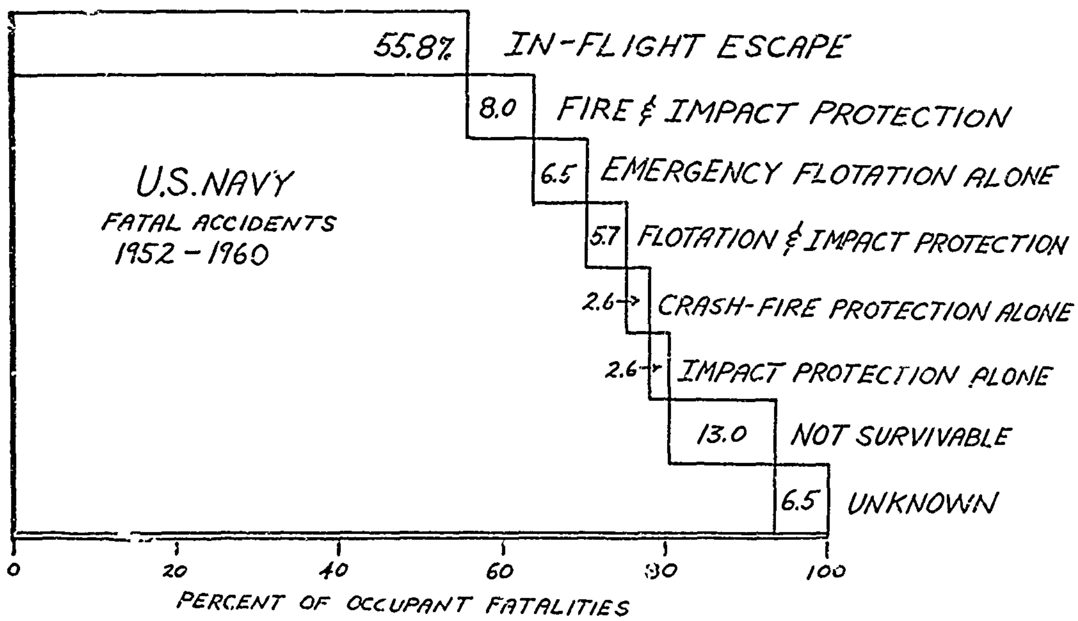

Fig. 2 Survival requirements in fatal helicopter accidents, 1952-1960

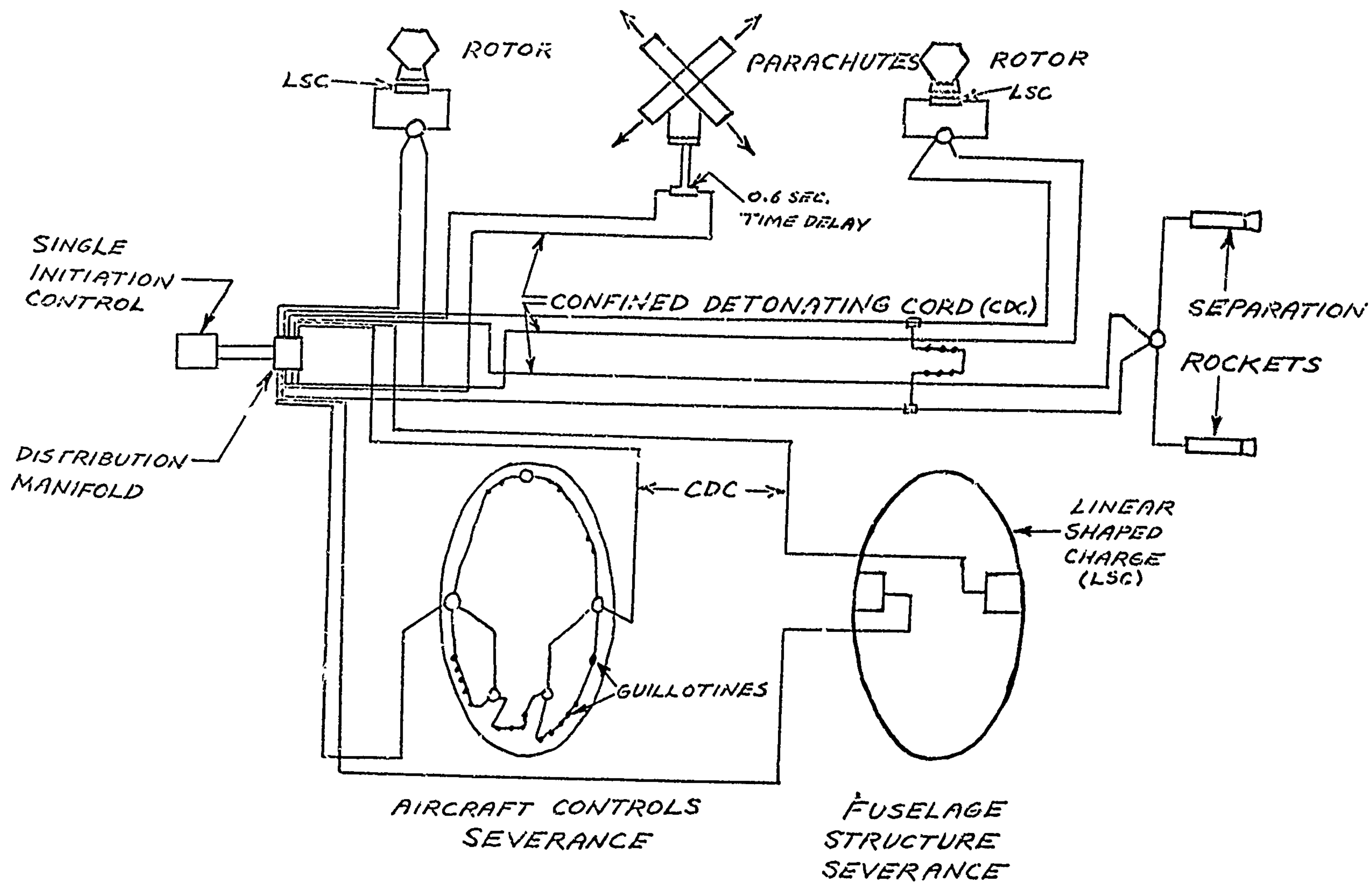

Fig. 3 Schematic, capsule escape system installation for UH-25B

Fig.4 UH-25B in remote controlled flight.

Fig.5 Capsule system initiation

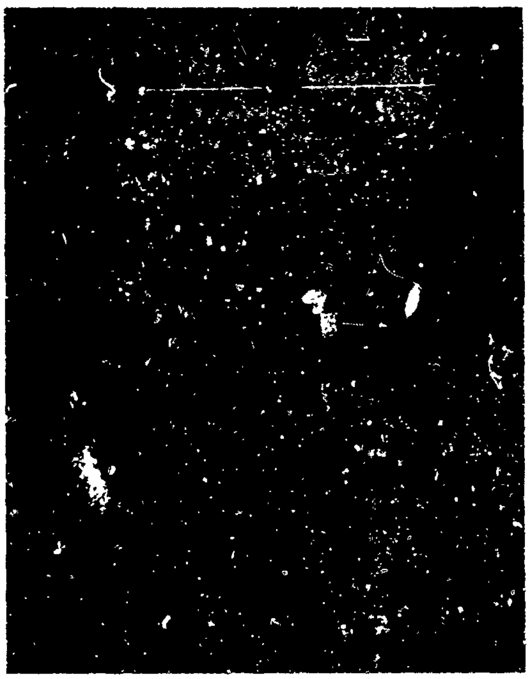

Fig.6 Fuselage and rotor blade jettisoning

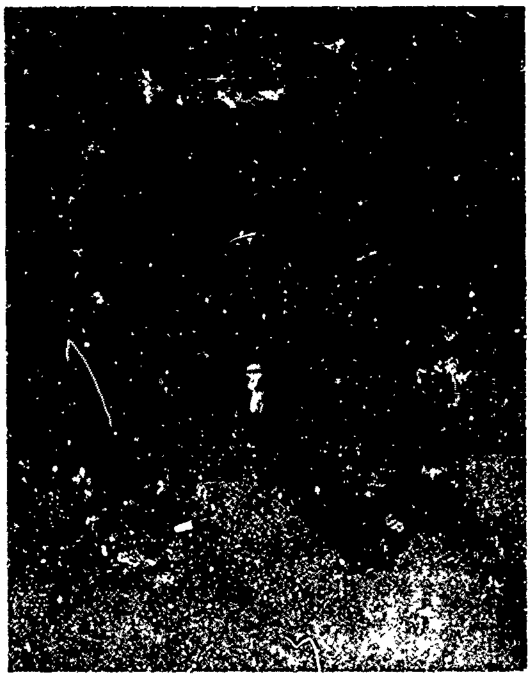

Fig.7 Ballistic deployment of four 35 foot diameter parachutes

Fig.8 The parachutes ballistically spread

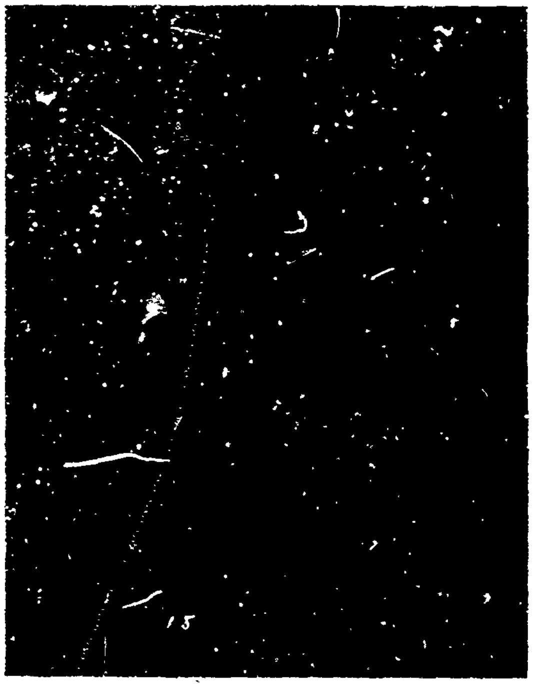

Fig.9 Start of capsule recovery

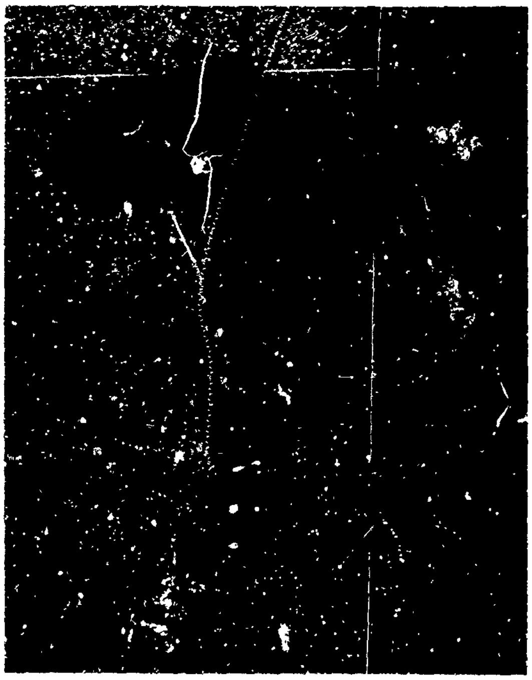

Fig.10 Recovery

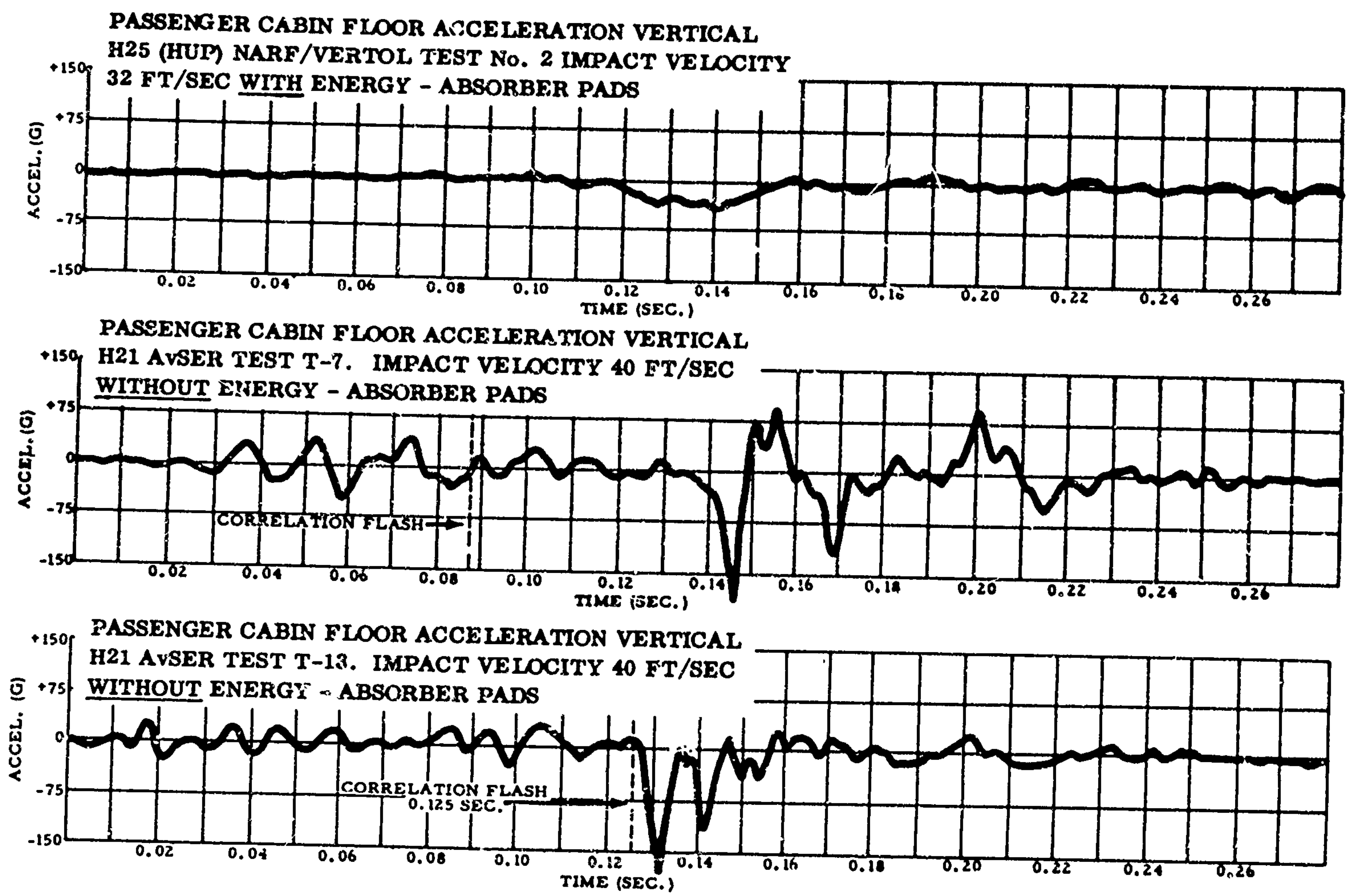

FIGURE OSCILLOGRAPH TRACES OF CONTROLLED HELICOPTER DRONE CRASHES

Fig. 11 Impact loads recorded during controlled helicopter drone crashes

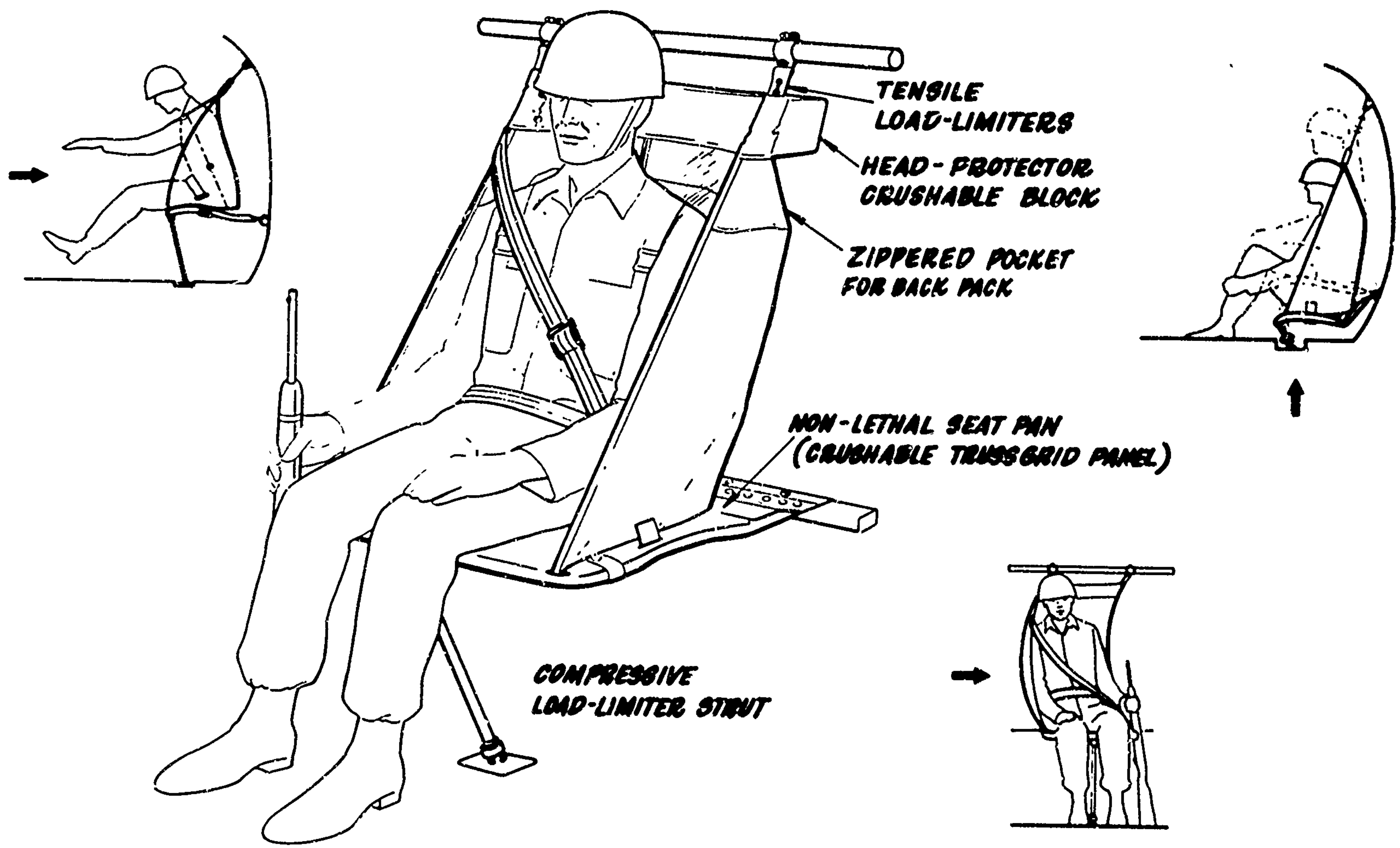

Fig. 12 Troop seat with energy absorption capabilities

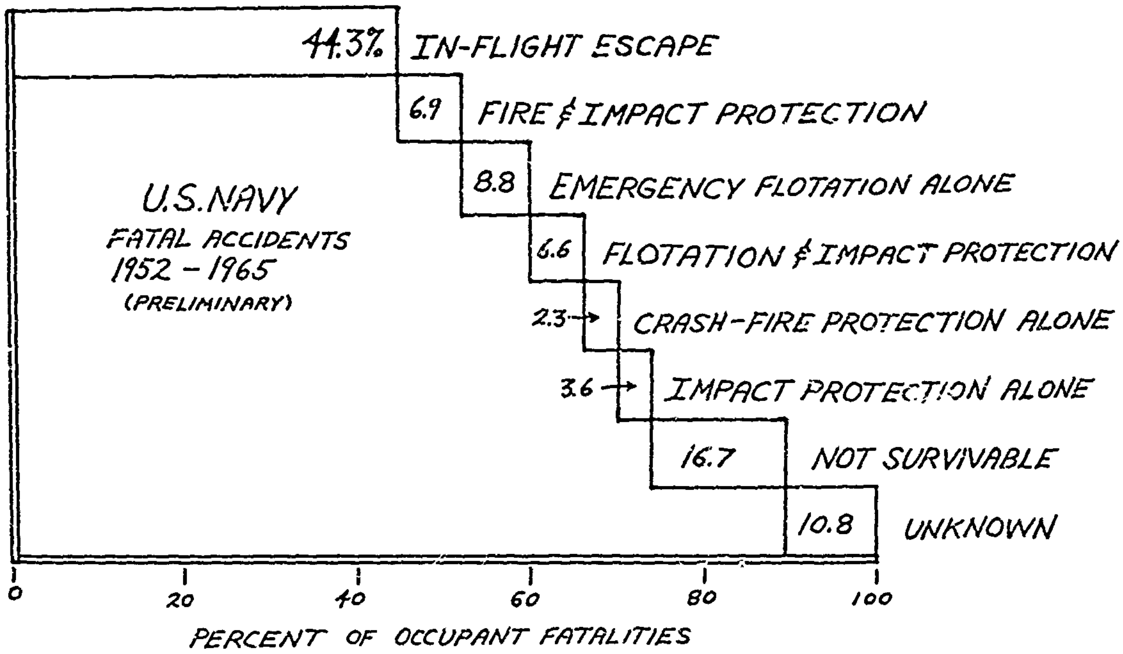

Fig. 13 Survival requirements in fatal helicopter accidents, 1952-1965

HELICOPTER PERSONNEL ESCAPE, PROTECTION, AND SURVIVAL SYSTEM

CAPSULE	PROTECTION/ SURVIVAL
<u>INITIATION SUBSYSTEM</u> INITIATORS, ENERGY TRANSFER, LEADS, AND MANIFOLDS	FIRE PREVENTION AND EXTINGUSIHING
<u>SEVERANCE SUBSYSTEM</u> EXPLOSIVE CUTTING EXPLOSIVE GUILLOTINE	ENERGY ATTENUATING MATERIALS AND DEVICES LIFE PRESERVERS AND FLOTATION EQUIPMENT
<u>SEPARATION SUBSYSTEM</u> ROCKETS/THRUSTERS	SURVIVAL KITS
<u>RECOVERY SUBSYSTEM</u> BALLISTIC PARACHUTES RETRO-ROCKETS	HELICOPTER ARMOR PERSONNEL ARMOR

Fig. 14 Subsystem/component make-up of Helicopter Personnel Escape, Protection and Survival System

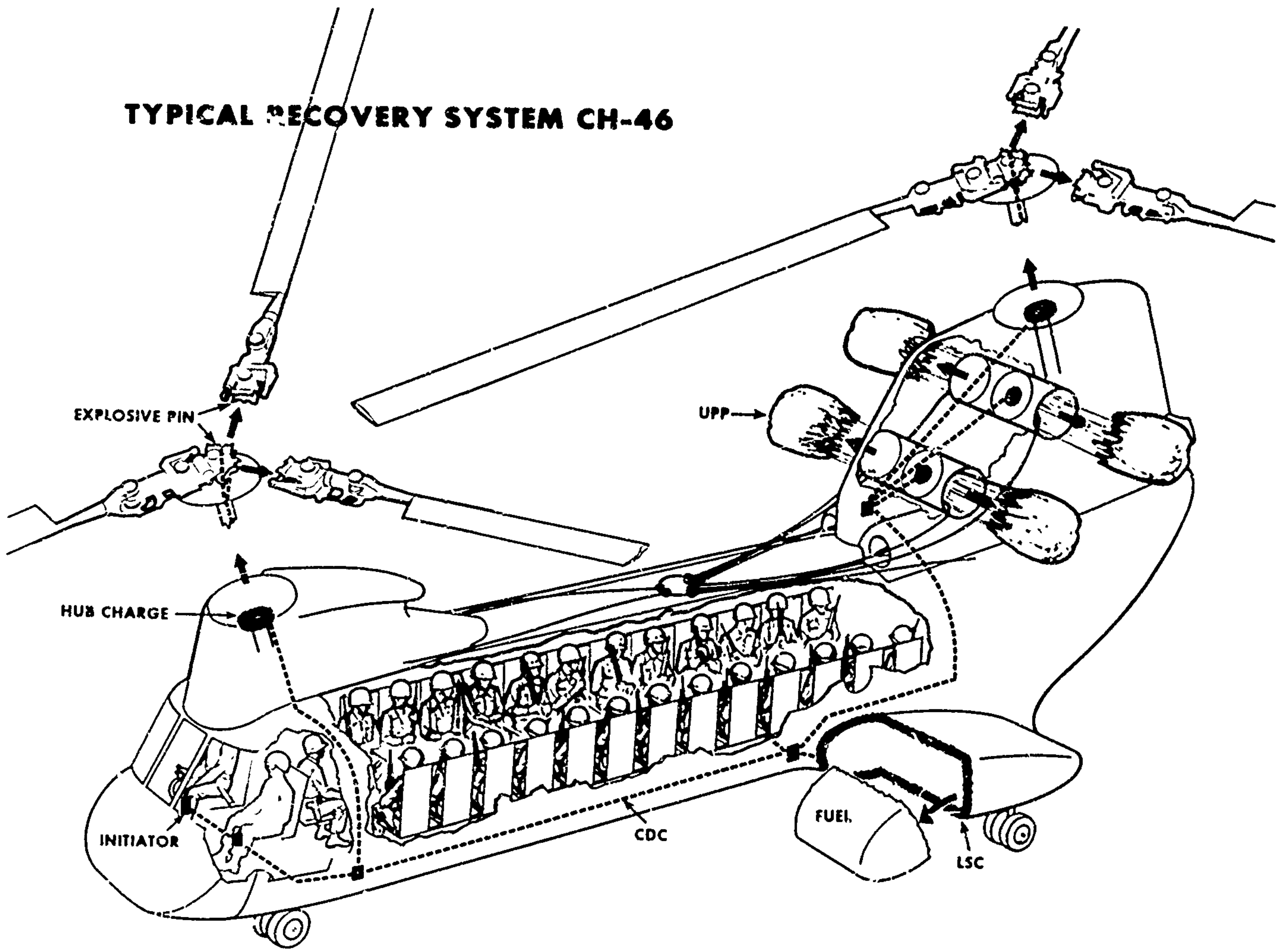

Fig. 15 Pictorial view of system in CH-46 helicopter

CRASH INJURIES IN US ARMY HELICOPTER ACCIDENTS

by

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RESUME

L'auteur dresse un tableau général des blessures dues aux accidents d'hélicoptères (lieux, fréquence, gravité) dans l'Armée de Terre des Etats-Unis. Bien que, dans 95% des cas, on puisse survivre aux principaux accidents d'hélicoptères, 22% des décés ont lieu dans des conditions où la survie aurait été possible. L'auteur étudie le mécanisme de ces décés qui pourraient être évités, ainsi que les mesures prises pour réduire le taux de morbidité et de mortalité.

CRASH INJURIES IN US ARMY HELICOPTER ACCIDENTS

Captain E. L. Mattox, US Army, MC

INTRODUCTION

With the emergence of the tactical airmobility concept, the commander has become equipped with instruments of vertical envelopment. In US Army aviation, this is now most commonly accomplished with rotary wing aircraft.

With approximately 8000 rotary wing aircraft and 10,000 pilots in its inventory, the experience of the US Army with helicopter operations is the most extensive in the free world. Intensive training requirements, "nap of the earth" flying, and an increased exposure to hazards, unfortunately result in mishaps. The incidence of these accidents and the associated injuries are the subject of this paper.

The United States Army Board for Aviation Accident Research (USABAAR) located at Fort Rucker, Alabama, is the Army's repository for world-wide Army aircraft accident data (AR 15-76). The data presented here are taken from operational major and minor accidents (as defined by AR 385-40) exclusive of the Republic of Vietnam, for the time period 1 January 1961 thru 30 June 1965.

DISCUSSION

Correlation of accidents in Army helicopter experience to injuries incurred in them requires an analysis of the operational envelope. Most US Army aircraft fly in and out of confined areas at relatively slow speeds and low altitudes. Operational areas are frequently complicated by wires, trees, towers, and rough terrain at the landing site. Helicopters are not equipped with ejection seats and because of the altitude and mission flown, parachutes are not worn by the aviators. US Army helicopters operate in an environment that nears the extreme both in density of traffic and operational terrain. Therefore, although the helicopter has the capability to "autorotate" in case of inflight emergency, the aviator must always "ride the helicopter in".

TABLE I

US Army Helicopter Accident Experience

Fiscal Year	*Accident Rate**	*Hours*
61	28.1	557,409
62	37.1	603,905
63	35.8	619,463
64	28.1	717,464
65	22.7	842,309
66	15.7	1,014,821

* Rate = Number of accidents per 100,000 hours.

Since the organization of USABAAR and the increased command emphasis on aviation safety, the Army's aircraft accident rate per 100,000 flying hours has decreased. (Fig. 1.) Considering the number of takeoffs and landings in helicopters, although not ideal, the present accident rate, 15.7, is not necessarily excessive and compares favorably with the Army's fixed wing accident rate.

TABLE II

Accident Incidence

Accidents	*Total*	*Surv.*	*Nonsurv.*
Number	756	718	38
With Injuries	289 (38%)	251 (35%)	38
Without Injuries	467 (62%)	467 (65%)	0

These figures include total major accidents both survivable and nonsurvivable. Injuries are not usually incurred in incidents, forced landings, and precautionary landings and are therefore not included in these figures. Although the margin between a forced landing and a major accident is frequently the pilot's skill or the availability of suitable terrain for landing, the fact remains that injuries are infrequent in other than major accidents.

TABLE III

Occupants of Helicopter Accidents

	Total	*Surv.*	*Nonsurv.*
Number of Occupants	2187	2068	119
Occupants W/Injuries	527 (24%)	402 (20%)	119
Occupants Wo/Injuries	1666 (76%)	1666 (80%)	0

There was an average of three occupants per helicopter accident with 24% of the occupants receiving injuries of at least a minor degree. There were a few miraculous escapes in nonsurvivable accidents (i.e., thrown clear of aircraft just prior to impact), who received major, but non-fatal injuries.

TABLE IV

Fatality Experience

	Total	*Surv.*	*Nonsurv.*
Accidents	756	718 (95%)	38 (5%)
Fatalities	149	33 (22%)	116 (78%)

It is noteworthy that 95% of US Army helicopter accidents are classified as survivable. Survivability is determined by the flight surgeon investigating the accident and by USABAAR after an analysis of crash forces, cockpit deformation, and post-crash conditions. An accident may be survivable for one occupant and nonsurvivable for another. In general, the determination is not difficult - that is, very few accidents fall into the "gray" area of borderline human tolerance.

Theoretically, there should be no deaths in survivable type accidents. When deaths do occur in these noncatastrophic type accidents, they are most usually due to a failure, lack of use, or inadequacy of restraint systems or personal protective equipment[5].

TABLE V

Change in Fatality Experience

	1957-1960	*1961-1965*
Survivable Accidents	97%	95%
Fatalities in Survivable Accidents	46%	22%
Primary Cause of Death in Survivable Accidents	Head Injury	Burns & Complications

Although the incidence of noncatastrophic accidents has not significantly changed since 1957, the percentage of deaths occurring in these accidents has been significantly reduced[1]. The following factors have contributed to this reduction in mortality:

(a) Increasing emphasis on crashworthy aircraft design, including cockpit delethalization.

(b) Improvements in the restraint system (including seat, seat attachments, lap belts and shoulder harnesses).

(c) Increased emphasis (supply, command, and individual) on adequate personal protective equipment - most notably the protective crash helmet.

(d) More rapid medical evacuation and treatment of critically injured occupants both in the training and tactical situation (especially the use of the medical evacuation helicopter).

(e) Increased aviator acceptance on use of signaling and survival equipment resulting in early rescue and/or self-treatment.

TABLE VI

Degree of Injury in Survivable Accidents

Occupants	2068
No Injury	1666 (80%)
Minor Injury	245 (12%)
Major Injury	124 (6.5%)
Fatal Injury	33 (1.5%)

Even though noncatastrophic US Army helicopter accidents expose the occupants to relatively high decelerative forces, the number of occupants injured in survivable accidents is relatively low. When injury does occur, the degree is minor in the majority (61%) of mishaps.

TABLE VII

Injury in Survivable Accidents

Wounds (Lacerations and Abrasions)	427 (60%)
Fractures	119 (17%)
Burns	62 (9%)
Sprains/Dislocations	53 (7%)
Misc/General	16
Environmental (exposure, etc)	12
Multiple Extreme	10
Concussion	8

Injury type, severity, locations, etc. are analyzed principally in survivable accidents for the following reasons:

(*a*) Injuries in catastrophic, high G force accidents usually involve every body system (multiple extreme) and are quite often complicated by total body burns.

(*b*) Nonsurvivable accidents result in fatalities to the occupants except in extremely rare acts of fate. It would be impractical, if not impossible, to design aircraft or protective equipment to prevent voilent death when the decelerative forces are excessive – e.g., loss of a main rotor above 50 feet.

(*c*) Analysis of injury profiles in survivable accidents gives the designers of personal equipment and aircraft structure guidelines for reduction of morbidity and mortality in these occurrences. Aviation Safety and Engineering Research (AvSER), a branch of the Flight Safety Foundation, working under contract with the US Army and other aviation agencies, has developed an aircraft designers guide[6]. This handbook summarizes known information useful in building crashworthiness into aircraft. This concept has already been applied to some US Army aircraft with gratifying results.

(*d*) Specific injury patterns in nonsurvivable accidents are meaningful primarily to the aviation pathologist and accident investigation team in correlating the specific events of a specific accident. Tabulation of injury patterns in these catastrophic accidents loses its application as it becomes a list of massive injuries to all body systems.

The three most common injuries in survivable accidents are lacerations, fractures, and burns. The most common major injury is an open fracture of the tibia. The etiology of this injury is usually involvement with structures in the nose of the helicopter, most commonly the radio console. Attempting to exercise maximum control during the split seconds of the crash sequence, the pilot has his feet firmly on the anti-torque pedals. The greater the forward velocity, the greater the crumpling of the forward aircraft structures which then impinge on the tibial area. The resultant level system results in fractures from both contact and decelerative forces, while there are lacerations both from broken bones and contact with aircraft structure.

TABLE VIII

Body Injury in Survivable Accidents

Upper Extremity	156 (22%)
Lower Extremity	144 (20%)
Back	92 (13%)
Head (exluding face)	78 (11%)
Face	75 (10%)
Thorax	60 (8%)
Generalized	40 (6%)
Abdomen	21
Neck	25
Pelvis	6

Excluding the back injuries, the most common body locations for trauma in survivable helicopter accidents are those parts of the body most distant from the restraint system. This peripheralization is due in part to the flailing which is present whenever the decelerative forces are greater than mild (greater than 3-6 G's).

The back injuries range from simple cuts and bruises, "strain" in the paraspinous muscles to compression fractures. This injury is usually attributed to a high vertical impact force and sudden flexion/extension moments.

TABLE IX

Cause of Death in Survivable Accidents

Burns and Complications	10 (30%)
Multiple Extreme	6 (18%)
Head Injuries	5 (15%)
Hemorrhage and Shock	3 (9%)
Heart/Great Vessel Trauma	3 (9%)
Hemopneumothorax	2
Chemical Pneumonia	2
Drowning	1
TOTAL	33

Although death is infrequent (1.5%) in survivable accidents, theoretically it should not exist. Thermal hazards not only contribute to the cited mortality, but also, as indicated earlier, have a considerable morbidity in survivable accidents (9% of injuries). This morbidity is especially significant when the extensive treatment period and probable loss of an aviator from flying duty are considered. Fire damage to property and aircraft loss are furthermore significant[4].

The other cuases of death are not statistically significant when considering the sampling. Although there is frequently a mental image of generalized massive trauma when one considers a fatality in a helicopter accident, multiple extreme injuries are rare in almost all survivable helicopter accidents.

TABLE X

Cause of Death in Nonsurvivable Accidents

Multiple Extreme	72 (62%)
Head Injury	17 (15%)
Burns and Complications	12 (10%)
Heart/Great Vessel Trauma	9 (8%)
Spinal Cord Transection	4
Generalized Hemorrhage	1
Hemopneumothorax	1
TOTAL	116

Although nonsurvivable helicopter accidents are infrequent (5%), 78% of the deaths occurred in them. The causes of death in these catastrophic impacts are listed for academic interest. The multiple extreme injury is the most frequent, usually involving most body areas, systems and injury types.

TABLE XI

Helmets and Head Injuries in Survivable Accidents

Occupants with Head Injury	153
Fatalities from Head Injuries	5
Helmets Lost at Impact	41
Head Injuries Due to Helmet Loss	35
Helmet Prevented Injury	59

Although death in survivable accidents is rarely attributable to head injury, there is quite a morbidity associated with this trauma.

The protective helmet (APH-5) was made an item of US Army aviation issue in 1959. Since that time head injuries, morbidity and mortality have been reduced drastically[2]. However, when the helmet is improperly fitted or improperly worn, it is frequently lost during substantial impact, especially in helicopter accidents[3]. Injuries are frequent (85%) when the helmet becomes dislodged at impact. The five fatalities from head injury either lost their helmets at impact or were wearing no helmet. There have been a few head injuries received because the aviator removed the helmet prior to evacuating the wreckage (after impact). A victim of habit, he received lacerations from jagged structure.

TABLE XII

Head Injury Type in Survivable Accidents

Wounds (Lacerations & Abrasions)	125 (73%)
Burns	25 (14%)
Concussion	8
Fractures	6
Miscellaneous	8

Simple lacerations occur most commonly and are usually in the range of 1 to 3 inches in length and ¼ to 1 inch deep. Burns are not only disfiguring, but as the nose and mouth are portals, inhalation of flames results in respiratory burns which may lead to a pulmonary death. Wounds and burns can be classified as injuries secondary to contact whereas concussion and fracture are functions of impact.

TABLE XIII

Head Injury Location in Survivable Accidents

	Superficial Structures	*Deep Structures*	*Total*
Face	81 (56%)	2 (13%)	83 (52%)
Frontal Area	22 (15%)	2 (13%)	24 (15%)
Occipital Area	11 (7%)	0	11 (7%)
Parietal Area	7	1	8 (5%)
Temporal Area	6	2 (13%)	8 (5%)
Ears	7	0	7
Chin	5	0	5
Lips	5	0	5
Brain	0	4 (27%)	4
Basilar Area	0	2 (13%)	2
Nasal Area	0	1	1
Mandible	0	1	1
TOTAL	114 (91%)	15 (9%)	159

The most common head injury is a simple laceration of the face. Ninety-one percent of head injuries in survivable helicopter accidents are superficial. These most commonly are minor wounds and have *not* resulted in any mortality. Deaths from head injuries and significant morbidity are produced when there is trauma to deep structures. There have been no fatalities secondary to fractures of the facial bones. Deep injuries to the occipital area have not yet occurred in survivable helicopter accidents.

TABLE XIV

Back Injuries in Survivable Accidents

Fractures	42 (46%)
Wounds	33 (36%)
Sprain/Strain	17 (18%)
TOTAL	92

Back injuries in survivable helicopter accidents are classified as fractures, wounds (lacerations, etc.) and sprains/strains. Recovery from skin and muscle trauma is usually relatively rapid, whereas compression fractures can produce long term morbidity.

TABLE XV

Vertebral Fractures in Survivable Accidents

Cervical	1
Thoracic	14 (33%)
Lumbar	26 (62%)
Sacral	1
TOTAL	42

Since the introduction of the low silhouette type helicopter, there has been an increase in vertebral fractures due to the generally high vertical decelerative forces and the absence of crushable material between the pilot and the bottom of the aircraft. With increased emphasis on honeycombing, seat structure collapse at "G" forces just short of those which would produce spinal injuries, and other crashworthiness engineering features, such morbidity can be reduced to a minimum.

Spinal fractures in survivable helicopter accidents most frequently occur at the low thoracic, high lumbar area, where the curvatures of the spine are the greatest. Thoracic fractures might be postulated to be a function of posture, whereas a lumbar fracture is probably more a function of decelerative forces.

CONCLUSIONS

Ground impact varies from a hard landing during an autorotation to severe decelerative forces encountered during uncontrolled contact with the ground. In spite of the relatively high exposure to injury, most major helicopter accidents are within defined human tolerance limits[5,6].

Stated simply, morbidity and mortality in noncatastrophic helicopter accidents can be reduced if:

(*a*) The inhabited area remains relatively intact.

(*b*) The occupants are restrained in this "livable" environment.

(*c*) There is energy absorption by the aircraft structure through use of design, honeycombing, load limiters, etc.

(*d*) There is energy absorption between the vital body structures (torso, vertebral column, and head/neck), and the impact points. Helmets, seat structure, etc. participate in this attenuation.

(*e*) Post-crash fire hazards are reduced through the fuel containment (crash resistant fuel cells and emulsified fuels), fuel cell location and thermal protection (fire retardant flight suits, etc.).

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DISCUSSION

There was considerable discussion on the problems of meeting the generally accepted requirement of a universal-fit protection helmet for passengers.

Lt Cdr Williams stressed the Royal Navy's belief in the inherent advantage of twin-engine craft and Col Cody commented that this, too, was the policy of the US Army.

On the general topic of sophisticated escape systems Brig Gen Lauschner pointed out that the low injury rates quoted by Capt Mattox might make it very difficult to convince financiers of the need for such systems.

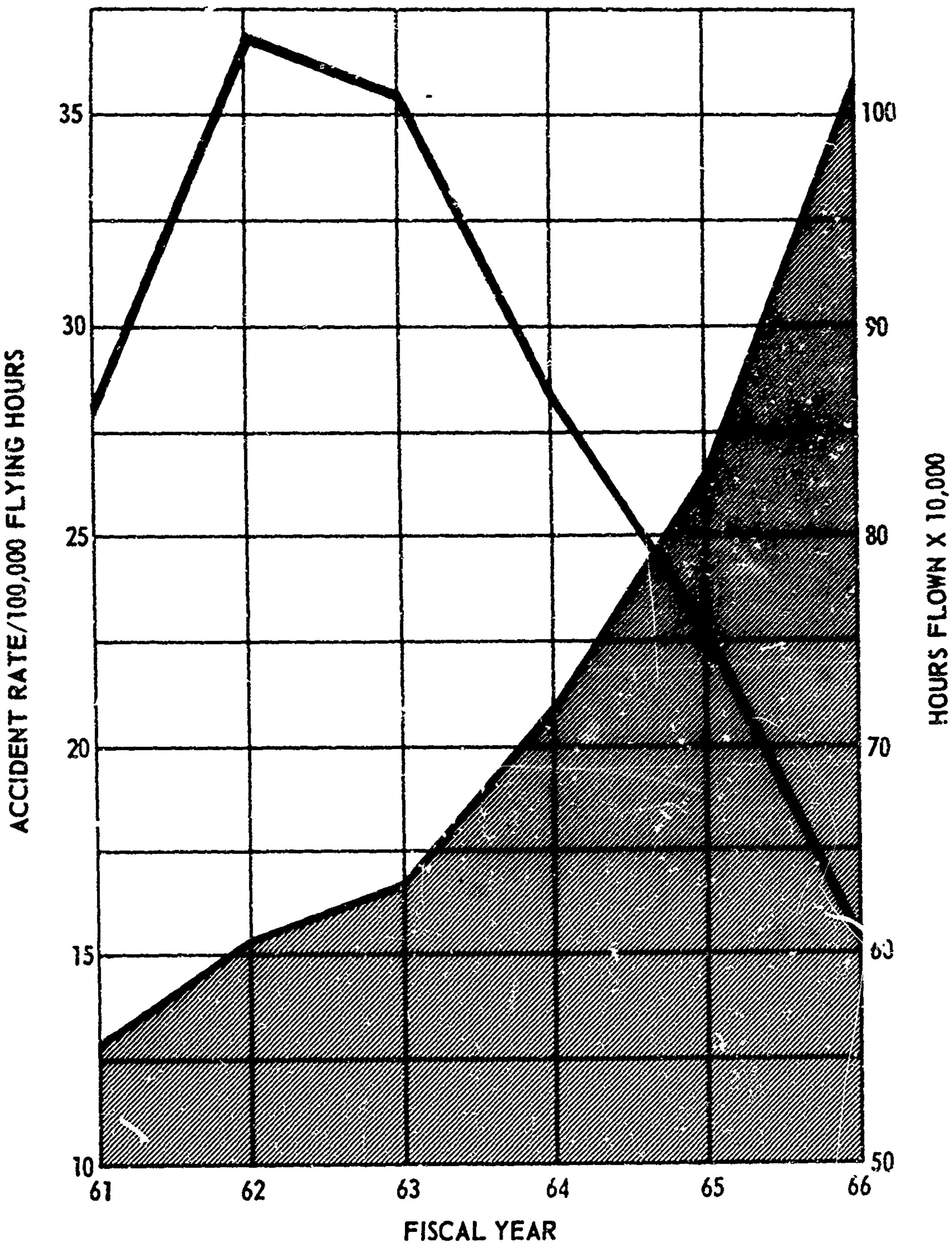

Fig. 1 US Army helicopter accident rate and flying hours

EMERGENCY LANDING AND DITCHING TECHNIQUES IN HELICOPTERS

(USABAAR Report P67-1)

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RESUME

Les chances de survie au cours d'un atterrissage forcé dans des conditions hostiles reposent, pour une grande part, sur l'aptitude du pilote à utiliser à des fins d'absorption d'énergie les parties de la structure de l'appareil dont on peut se dispenser pour la survie. L'aérodynamique de l'hélicoptère et ses caractéristiques structurales – en particulier la répartition des éléments de la structure dont on peut se dispenser autour de la surface occupée par le pilote et les passagers – prescrivent une technique diamétralement différente de celle que l'expérience a confirmée pour les appareils à voilure fixe. Alors que le pilote d'un avion à voilure fixe peut contrôler sa vitesse de descente, le pilote d'un hélicoptère peut contrôler sa vitesse d'impact avec le sol; alors que les éléments structuraux dont on peut se dispenser, sur un appareil à voilure fixe, sont plus particulièrement aptes à arrêter un mouvement vers l'avant, ces mêmes éléments, sur un hélicoptère (en particulier le rotor) se prêtent davantage à l'amortissement d'un impact vertical. L'auteur étudie la technique optimale d'atterrissage forcé sur les hélicoptères modernes à silhouette basse; cette technique a été mise au point par le Conseil de l'Armée de Terre US pour les Enquêtes sur Accidents Aériens (US Army Board for Aviation Accident Research) sur la base, d'une part, de l'expérience acquise dans le domaine des accident, d'autre part, d'essais vraie grandeur.

EMERGENCY LANDING AND DITCHING TECHNIQUES IN HELICOPTERS

G. Bruggink

1. CRASH SAFETY CONCEPTS FOR PILOTS

1.1 General

A pilot needs some understanding of the mechanics of crash injuries if he is to make the wisest decision in a forced landing situation that looks grim at best. The following discussion is intended to give this understanding without getting involved in the medical and engineering aspects of the subject.

Crash injuries, like aircraft damage, are the result of the violence generated by sudden stoppage. These injuries fall into two broad categories:

1. Contact injuries, resulting from forceful contact between the occupant and environmental structure. This is the most common form of injury during forward decelerations, when the occupants do not use an adequate restraint system (seat belt *and* shoulder harness). Injuries caused by loose objects in the cockpit/cabin area also fall into this category.

2. Decelerative injuries. Although all contact injuries involve a deceleration process, the term "decelerative injuries" is generally used to indicate bodily damage resulting solely from loads directly applied through the occupant's seat and restraint system. They affect the body internally and one of their characteristic forms is the spinal injury during vertical decelerations (excessive positive G). Internal injuries caused by seat belt impact in the lower abdomen may occur during severe forward decelerations, especially when the seat belt is not properly installed or used. (NOTE: The seat belt should cross the hips at about a 45° angle and the buckle should be worn as low as possible, so that decelerative loads are applied to the hip bones and not to the soft abdominal area.)

Injuries resulting from post-crash complications form a separate category. Fuselage distortion and final aircraft attitude may interfere with the timely evacuation of the wreckage in case of fire or during ditching. Although this hazard can be controlled to some extent by the design of fuel systems, and emergency exits, it is mainly the pilot's landing technique and his knowledge of the aircraft that govern the post-crash survival aspects.

The vio ence of the stopping force, expressed in G's, depends on speed* and stopping distance. Speed, in itself, is not a killer; the danger lies in how it is dissipated. A common misconception in this respect is that it takes hundreds of feet of obstacle-free terrain to make a survivable crash landing. Theoretically, it would take only 20 feet to decelerate an aircraft from 100 to 0 knots at a tolerable level of about 20 G's, if the stopping force could be applied uniformly over this distance. The same uniform deceleration (20G) would bring an aircraft to a stop from 60 knots in a distance of about 8 feet. The arresting gear of aircraft carriers and runway barriers show how this concept can be applied under controlled conditions.

The problem in some crash landings is that the deceleration process is not uniform; every time the aircraft strikes an obstacle or digs a gouge mark, a peak deceleration occurs and it is during these peaks that injury exposure is at its greatest. It should be pointed out, however, that as far as impact survival is concerned only the forces transmitted to the occupiable area (cockpit/cabin) are critical; the dispensable structure (nose section, wings, main rotor, etc.) should be used (sacrificed) as an energy-absorbing buffer between the point of impact and the cockpit/cabin structure.

The pilot should look at the cockpit/cabin inclosure as a protective container and try to keep this container reasonably intact by instinctively avoiding direct impact against this structure. Accident experience and full-scale experimentation have shown that reasonably intact cockpit/cabin structure generally means that the impact conditions were survivable, deceleration-wise. In other words, as long as the pilot can avoid collapse or excessive deformation of the protective container, he has met the first requirement for impact survival.

The second requirement that the occupants should participate as closely as possible in the deceleration of their immediate environment by means of their support system (seat, seat belt, shoulder harness). Any time the occupants' body - or part thereof - is allowed to gain velocity with respect to environmental structure serious body blows may be expected. Disregard for this basic law of physics kills thousands of car drivers needlessly every year in front-end collisions. Even when he is using a seat belt, the driver's upper torso and head may gain momentum with respect to his rapidly slowing-down car interior, resulting in a sledge hammer like impact against the steering wheel, instrument panel, or windshield. The obvious conclusion is that the car or aircraft occupant needs adequate restraint - which always includes a shoulder harness - since he has to slow down at the same rate as his environment. This basic requirement for impact survival in any type of vehicular crash is illustrated in the following hypothetical example.

During the roll-out after an emergency landing, an aircraft runs nose-first into a solid obstacle at 20 mph, crushing the nose section and shortening it by one foot. Assuming the deceleration is uniform, a one-foot stopping distance for the cockpit

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* The total energy of motion (crash energy) of an aircraft is a function of its groundspeed and varies as the square of the velocity. Example: Assuming a 20-knot wind, an aircraft with a 60-knot stalling speed could be landed with a groundspeed of 40 or 80 knots, depending on landing direction. Under normal conditions, the downwind landing would require four times as much rollout distance as a landing into the wind, assuming similar braking action. In a crash situation, the same four-to-one relationship holds true for the aircraft's total crash energy.

behind the nose results in a mean deceleration of 13.6G*. The pilot, who is not using his shoulder harness, jack-knives over his seatbelt, striking his head on the instrument panel. Assuming that the panel has stopped by the time he reaches it, the impact velocity of his head will be 20 mph. Assuming that the panel crushes to a depth of one inch, the effective stopping distance of the pilot's head will be 1/12 of a foot. This will result in a head impact of about 164 G's, or twelve times that of the overall cockpit deceleration. Depending on the shape and hardness of the head impact area, and whether or not a crash helmet is worn, this could easily be a fatal blow.

In addition to understanding the reaction of aircraft structure to crash loads, the pilot must have a general knowledge of the reaction - and the tolerance - of the human body under these conditions. The notion that there is a similarity between the human tolerance to G-loads resulting from flight maneuvers and the tolerance of G-loads imposed in crash-type decelerations should be discarded. Flight loads are of long enough duration to affect the blood circulation, for which the body has a very limited tolerance; unconsciousness may occur at about 4 to 6 G's. Impact loads are measured in fractions of a second and impose a mechanical shock for which the body has a rather high tolerance - about 20-25 G's positive (parallel to the spine) and over 40 G's during decelerations perpendicular to the spine when restrained by a seat belt and a shoulder harness. With a seat belt only, this tolerance to forward deceleration drops below 25 G's. Actually, the human body can take more punishment than the aircraft structures under consideration, as long as the pilot manages to maintain a semblance of integrity in the occupiable area and avoids forceful contact with his environment.

1.2 Crash Dynamics. Fixed Wing

There is no need to explain that an emergency landing in a fixed wing aircraft always involves forward velocity (groundspeed). Naturally, the pilot should aim at the lowest practicable groundspeed but never in exchange for an abnormal rate of sink. One of the least understood factors in crash landings is the abrupt dissipation of the aircraft's vertical component of velocity on first ground contact. The severity of this peak vertical deceleration is governed by the vertical velocity (rate of sink), the crushability of the structure under the cockpit/cabin area, and the nature of the terrain. If the structure is rigid - as is the case in most low-wing aircraft - and the terrain hard, very high vertical forces may be transmitted to the occupants even at moderate sink rates. Under these conditions an extended - and collapsing - landing gear would definitely assist in reducing the peak vertical deceleration; however, this advantage should be weighed against possible hazards introduced by landing gear failure such as fuel spillage and fire

In single-engine aircraft with fixed, fuselage-mounted landing gear, or with a radial engine, a hard flat touchdown on soft terrain may cause the digging in of the landing gear bulkhead or the lower half of the engine. This abrupt plowing effect at first ground contact may result in extremely high horizontal decelerations on otherwise unobstructed level terrain.

The horizontal deceleration of freely sliding wreckage is very low. On a smooth hard surface, such as a runway, the stopping force is proportionate to the coefficient of friction and, therefore, always less than one G. However, at initial impact this

* G formula used: $G = 0.034 \frac{mph^2}{S}$. (Stopping distance, S , in feet).

horizontal stopping force has to be multiplied by the vertical G load resulting from the reduction of the sink rate to zero. (This is the same force mechanism that tears off landing gears in hard touchdowns with the brakes locked.)

Wings and landing gear are the primary "drag devices" to stop the aircraft's forward motion. Long nose sections with collapsible structure can also be used for this purpose, if aft displacement of the nose structure does not immediately affect the cockpit's integrity. Some of the modern, short-nosed, single engined aircraft are poor examples in this respect. A severe nose-first impact in these aircraft will drive the engine into the instrument panel or the rudder pedal area. This reduction in occupiable area, in combination with the stretch in the restraint system or a failing seat, can easily make this type of accident non-survivable for the front seat occupants.

1.3 Crash Dynamics: Rotary Wing

Where the fixed wing aircraft's dispensable structure is especially suited to arrest forward motion, the helicopter's dispensable structure (landing gear, lower fuselage, tail boom, and main rotor) can be used mainly to alleviate vertical impact. Consequently the helicopter pilot has to be very cautious about forward velocity during excessively hard vertical impacts on soft terrain, or during a running landing between obstacles. The general rule for helicopters in this respect is: the worse the terrain, the more important it is to reduce the forward velocity of touchdown. Since a zero groundspeed touchdown requires more finesse, it would be unwise to use this technique when terrain permits a running touchdown.

What are the peak G-levels in a typical accident situation? A zero-groundspeed autorotation in a low silhouette helicopter, touching down on hard-packed terrain at a sink rate of 1500 feet/minute, would expose the occupants to a vertical load of about 24-40 G's*. Spinal injuries are likely to occur under these circumstances but survival would not be at stake. The cockpit/cabin area would still be relatively intact - although distorted - but the aircraft would probably not be economically repairable. If the same landing on hard terrain were made with forward groundspeed, a peak horizontal deceleration in the order of 15 to 25 G's would coincide with the peak vertical deceleration due to the increased frictional force while the vertical speed is being dissipated. A similar touchdown with forward velocity on *soft* terrain would probably be disastrous; the extremely high drag on the aircraft's bottom structure coupled with the forward inertia of the heavy components (transmission, engine, etc.) would tend to destroy the overall cockpit/cabin integrity. To avoid undue concern, it might be well to note that a 1500 foot/minute touchdown at zero groundspeed on soft terrain that allows one foot of additional vertical stopping distance would not have injurious effects.

The most important vertical impact attenuator is the main rotor, especially in low-silhouette helicopters such as the UH-1, where there is not enough structure under the occupiable area to cushion an excessive rate of sink. The ideal way to use the main rotor for this purpose is to make a zero-groundspeed tree landing, this causes the main rotor to act as an "umbrella" while the fuselage settles into the trees and loses its excess vertical velocity. (This technique is explained under the heading, "Touchdown".)

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* Based on an effective stopping distance of about 4 inches.

2. SETTING THE SCENE

From the pilot's point of view, there are two types of emergency landings:

(a) Forced landing: When further flight is impossible, but not as a result of catastrophic aircraft control problems.

(b) Precautionary landing: When further flight is possible, but inadvisable under certain conditions such as deteriorating weather, being lost, fuel shortage, and gradually developing engine trouble.

A precautionary landing, normally, is less hazardous than a forced landing because the pilot has more time for terrain selection, is subject to less stress, and can use power to compensate for errors in judgment or technique. Unfortunately, too many situations calling for precautionary landings are procrastinated into immediate forced landings because the pilot uses wishful thinking instead of reason, especially when dealing with a self-inflicted predicament. On the other hand, experience proves that an emergency situation that demands a quick, instinctive reaction without time for rationalization is often handled better than a situation that leaves time for "meditation" and "self-pity".

If serious injuries do occur in emergency landings, they generally result from lack of understanding of the basic mechanics involved, compounded by one or more of the following factors:

(a) Reluctance to accept the emergency situation. The pilot who won't face the fact that his aircraft will be on the ground in a very short time regardless of what he thinks or hopes is already handicapping himself. In his efforts to delay this dreaded moment, he tends to maintain his altitude at the expense of aircraft controllability. (Loss of speed and/or rotor r.p.m.)

(b) The desire to save the aircraft, even when it implies a course of action that leaves no margin for error. If all goes well, the aircraft may sustain little or no damage; if the pilot loses his gamble, the aircraft as well as the occupants may be lost. Stretched glides and failure to allow for obstacles in the approach path are typical under these conditions.

(c) Undue concern about getting hurt in a landing on rough terrain and its adverse effect on the pilot's judgment and technique.

To supplant all unnecessary apprehension by a justified dose of self-confidence, it might be best to introduce the chapters on actual landing techniques with the following statement:

A helicopter pilot who understands and uses the guidelines presented in this pamphlet is not going to expose himself or his passengers to fatal injury during emergency landings under the most adverse conditions.

3. TERRAIN SELECTION

Except for the few critical seconds following takeoff, a pilot never has an excuse denying himself some form of choice in the selection of an emergency landing site. This does not mean that he has to fly around preoccupied with engine failure and suitable landing spots, but rather, that he has to develop some protective instincts and sound habits in the following areas:

(a) Routing: Using imagination in the planning of a route goes a long way towards improving the survival aspects of a forced landing. The difference between a direct route which leaves no choice in case of an emergency and one that detours over "friendly" terrain is often a matter of only a few minutes or a few gallons of gas. The same type of defensive thinking should go into the selection of terrain over which local training flights are conducted and the direction of take-off from confined areas.

(b) Altitude and Airspeed: More altitude above terrain means more choice, time-wise and distance-wise. Excess airspeed can be converted into altitude and therefore, into terrain choice. Flying needlessly low and slow over neck-breaking terrain is one of aviation's capital offenses. However, excessive altitude is not a blessing when it leads to indecision. The helicopter pilot should probably learn to think in terms of optimum altitude: high enough to make an autorotation and low enough to get the aircraft safely and quickly on the ground in case of a critical malfunction.

It is unfortunate that in most training situations so much stress is placed on the selection of a field that actually allows a (simulated) forced landing without damage. This training practice and the bias it creates put heavy demands on the composure of a pilot who finds himself beyond gliding distance of a suitable field. What is he expected to do? Call his instructor for further guidance or a refund? Obviously, no flight training is complete unless the student has been conditioned to accept the inevitability of aircraft damage when circumstances force him to sacrifice dispensable structure to protect the cockpit/cabin area.

Assuming that the pilot is beyond reach of suitable landing area, he should judge the terrain within gliding distance for its energy-absorbing capability. If sufficient altitude is available, he should head towards the area that seems to offer the best choice without being immediately concerned about a specific spot. When the available time is very short, the choice may be limited to a variety of obstacles, but it is still a choice as long as the pilot maintains control of the aircraft.

The following discussion of the pros and cons of the different types of terrain is intended as general orientation only:

3.1 Trees (Forest)

Accident experience proves conclusively that in an emergency situation trees can be a helicopter pilot's best friend. In conjunction with the modern, all-metal, main rotor blade, trees have an energy-absorbing capability that may even compensate for partial loss of aircraft control or an excessive sink rate. In practical terms this means that under certain circumstances (e.g., low rotor r.p.m. or control difficulties) a tree landing may be less hazardous than one on flat, open terrain.

3.2 Water

It is difficult to explain the apparent reluctance of some pilots to ditch their helicopter in case of emergency. It may be the subconscious knowledge that the aircraft will most likely be a total loss, or fear of getting trapped. Based on actual experience, the ditching of a helicopter definitely presents much less of a problem, impact-wise, than a landing on very rough terrain or in high trees. If there are any problems they are mainly self-imposed ones in the form of premature evacuation of the occupants (before the main rotor has stopped) and failure to have all doors open at the time of water entry. The subject of ditching is covered separately in the last chapter of this pamphlet.

3.3 Desert

Selecting a suitable landing area in the desert should not present a problem. The survival and comfort aspects after landing, such as the proximity of settlements and the availability of water, food and shelter are sometimes more critical. For this reason, the original choice – when considerable altitude is available – should be one of direction rather than a specific spot. Since orientation is easily lost in the desert, it is advisable to make a mental note of a walk-out direction in relation to certain terrain features or the planned landing direction. This suggestion is made without inferring that a conspicuously located aircraft should be left in favor of an uncertain search for comfort.

3.4 Mountains

It is impossible to give general rules for terrain selection in mountainous terrain. What was said earlier about "giving yourself a chance" in case of an emergency definitely applies to the pilot's initiative and habits in mountain flying. The pilot should learn to instinctively avoid situations where an emergency would leave him without choice. Once he develops this instinct, the helicopter pilot will discover that the unique flying characteristics of his aircraft give him considerably more freedom from worry in rugged terrain than his fixed wing colleague.

4. APPROACH

Terrain selection from altitude is initially based on appearances, and therefore, not always final. As the actual terrain features become more apparent, the pilot should not hesitate to discard his original choice for one that is obviously better, but as a general rule, he should not change his mind more than once. A well planned and executed crash landing can be less hazardous than a wild approach into a large established field. Once the pilot has made his final decision he should suppress the tendency to keep looking for other – and hopefully better – fields and concentrate on the approach. The best advice here is to fly a normal landing pattern, without aggravating an already difficult situation by using non-standard or unproven procedures.

When the pilot has time to maneuver, the direction of the approach is governed by two factors: the wind and the location of obstacles in the approach path. A third factor – the dimensions of the chosen field – enters the picture only when ample landing space is available. A simple rule of thumb in the latter case is: When the wind velocity is ten percent of the touchdown speed, a downwind landing requires fifty percent more ground roll – or sliding distance – than a landing into the wind.

A critical situation is one where the only available field is a confined area that will accommodate the aircraft only when the pilot executes a flawless approach. From the pilot's point of view, this set-up is a perfect trap which he can avoid only by asking himself: From what direction should I approach to avoid disastrous results from possible errors in judgment and technique? Considering the two most obvious approach errors (coming in too high or too low) it is apparent that obstacles (wires, buildings, trees, etc.) permit only one type of error: coming in too high. To encourage the hard-to-convince pilot to treat obstacles with respect, the probable results of coming in too low are listed:

(a) Striking an obstacle during the final part of the approach almost always implies loss of aircraft control before the planned touchdown point is reached.

(b) Stretching the glide across obstacles to reach an open area means sacrificing rotor r.p.m. and yielding control over the rate of sink at touchdown.

The foregoing should make it clear that the approach direction into a confined area within gliding range is determined by obstacles as well as wind. To reiterate: The pilot should aim at a wind/obstacle combination that permits a controlled touchdown with the greatest margin of error. When there are no obstacles to contend with, wind should be an overriding factor only:

(a) When its effect is readily apparent in the aircraft's ground track.

(b) When there is sufficient time to do the necessary maneuvering without jeopardizing aircraft controllability.

Too many approaches go sour and end as serious mishaps because the crew pays too much attention to the fixing of whatever they thought went wrong (engine restarting attempts, etc.) and not enough to the planning and execution of the approach. Emergency landing procedures and aircraft control always take precedence over restart procedures, even if the pilot knows - which is the exception rather than the rule - that the situation is correctable within the available time. There is no need to explain that preplanned crew coordination for occasions like this can save the day.

In case of an erratically operating engine, it is often better to kill the engine - and shut-off the fuel - before final approach. This action not only preserves the pilot's initiative but it reduces or eliminates the most common fire hazard: a hot engine. (A turbine engine cools off extremely fast after flameout.) Another ignition source - the electrical system - should be handled in a similar manner when the pilot is no longer in need of the system's services and when time permits.

Advice concerning protective equipment should not be necessary since every helicopter pilot always has his seat belt, shoulder harness, and helmet chin strap fastened. Contrary to what most handbooks recommend, the locking of the shoulder harness (reel) is optional; it should be done only if time permits and if the pilot can do it without endangering aircraft control. The purpose of the automatic reel is to give the pilot the required freedom of movement in the cockpit while at the same time automatically protecting him in case of an abrupt deceleration (in excess of 2 to 3 G's). To obtain real benefit from the manual locking of the shoulder harness, all slack should be taken out of the straps after moving the control handle from automatic to manual.

5. TOUCHDOWN

Towards the end of the approach, the pilot is in the best position to judge his aircraft's remaining maneuvering capability with respect to the rapidly narrowing down terrain choice. He must now make the final decision about the exact touchdown spot and the manner of touchdown. This is not the time to get alarmed or revert to the supernatural because the terrain doesn't look as good as it did from altitude, or because the best area is overshot or undershot. Of all the errors that can be made up to this time, there is only one that's critical: loss of rotor r.p.m. and the resulting loss of control over the manner of touchdown.

The following discussion of touchdown techniques deals with landings on open terrain and tree landings.

5.1 Open Terrain

Before instinctively heading towards open terrain (including established fields) the pilot should ask himself the following questions:

1. Can I reach the open area with a normal glide without being tempted to stretch it? (Note: The speed for maximum glide distance, power-off, is not necessarily the same as the speed for minimum rate of descent.)

2. Does the surface permit a running landing in case of an excessively hard touchdown?

3. If I decide on a running landing, do I have sufficient aircraft control to insure a touchdown without drifting or crabbing?

4. If the surface conditions are poor, do density altitude and gross load permit a zero groundspeed touchdown at a reasonable sink rate or do I have the compromise in the form of a minimum ground roll touchdown?

As explained earlier, a running landing is less demanding with respect to pilot judgment and technique than a zero groundspeed touchdown. It may even be said that a straightforward emergency, such as an engine failure, over terrain that permits a running landing hardly presents a problem. However, the pilot has to be prepared for the most adverse conditions and for this reason his training cannot be considered complete unless he has been taught to perform a zero groundspeed autorotative touchdown.

5.2 Tree Landings

When a tree landing is unavoidable or preferable, the pilot should select a touchdown spot based on the following considerations:

1. The height of a tree is less critical than the height above the ground where it begins to branch. Tall trees with thin tops allow too much free-fall height after the aircraft passes through the branches.

2. When dealing with young or short trees (twice helicopter height or less), the most densely and evenly wooded area should be chosen. This is an ideal situation in which the bottom of the aircraft as well as the main rotor provide a cushioning effect.

3. When dealing with large trees, resistance against the bottom aircraft structure should be avoided in such a manner that the fuselage and tail boom will settle between the tree tops before the main rotor engages the branches of the surrounding trees. In other words, the pilot should look for an area where the rotor disk meets equal resistance at tree top level with the "softest" spot for fuselage and tail boom to insure a tail-low attitude at ground contact. The general implication is that, although their branches may overlap, tree trunks should provide a clearance of at least 1½ times the rotor diameter.

4. If at all possible, main rotor contact with heavy trunks high above the ground should be avoided as it may result in loss of main rotor or transmission failure. If a retreating (metal) blade strikes very heavy lumber, the tendency of the transmission is to fail in the forward direction (with counter-clockwise rotor rotation). The opposite is true when an advancing blade strikes a heavy obstacle, including the ground.

5. A landing in a sparsely wooded area may require more finesse than landing in a dense forest canopy since the few individual trees act as obstacles rather than energy absorbers. Under these circumstances, the terrain itself will probably be the main touchdown area and hitting an obstacel prior to touchdown often leads to loss of aircraft control and an uncontrolled crash. For example, if the left side of the rotor disk were to settle into trees while the right side met no resistance, the aircraft would tend to strike the ground on its right side.

6. Brush-type vegetation of less than helicopter height should be dealt with as if it were not there.

7. Clearings in woods should be treated with caution as they may contain tree stumps and other obstacles that may penetrate the aircraft's bottom.

8. Dead trees are dangerous; they offer little energy absorption and tend to puncture the fuselage.

9. A tree landing should be executed with zero or near-zero groundspeed and in a tail-low attitude. If for some reason the pilot is unable to reduce forward velocity to safe limits and tree contact is unavoidable, he should flare the aircraft in an extremely nose-high attitude against the densest growth and as close to the ground as possible. In this case, the pilot is using the trees to absorb energy of motion in the horizontal plane and the bottom of the aircraft becomes the main contact point as well as a protective shield. Even individual trees - preferably the smallest ones - can be used for this purpose if the center of the aircraft is aimed at the center of the tree crown. Uprooting a tree under these conditions adds to the impact attenuation process, as shown by accident experience.

As far as less yielding obstacles and man-made obstructions are concerned, the same concepts apply: Avoid nose-first contact under all conditions and avoid destruction of the main rotor until the aircraft is close to the ground and/or the forward velocity is negligible.

CONCLUSION

The reader is reminded that the purpose of this pamphlet is to increase the helicopter pilot's understanding of how to avoid or minimize the hazards associated with emergency landing situations. The intent is not to instruct the pilot how to fly his aircraft or to give the impression that the reading of these contents relieves him of the responsibility to maintain his routine skills and knowledge. The concepts and guidelines presented should be seen as a tool to sharpen the pilot's judgment in the utilization of available skills and knowledge under demanding circumstances: their proper application can reduce our already low occupant fatality rate (1%) in emergency landings to zero.

ADDENDUM

Useful additional data are found in a report entitled "Ditching the Huey", in the May 1967 issue of the US Army Aviation Digest.

DISCUSSION

Wg Cdr Eley expressed appreciation on behalf of all pilots present for the excellent work being done by such organisations as USABAAR. The 'wrapped' fuel tanks certainly seemed to be a great improvement but was there not in many helicopters a case for substitution of flexible hose for rigid fuel pipes? Mr Bruggink replied that this particular problem was being investigated at the moment.

Col Cody wished to support Mr Bruggink's case for the use of available trees to reduce impact forces in steep forced descents. He had seen many successful outcomes from the use of this technique.

SUMMARY OF SESSION IV

Gén. Maj. Méd. Evrard

Dealing with hazards of the helicopter one must first say that no flying apparatus is completely without a certain amount of potential danger to man. Therefore much work is to be concentrated on accident prevention and survival.

Icing still is a problem not very easy to cope with and complex devices are necessary for its study and practical prevention.

The rescue of helicopter crews after ditching has been very much improved during the past years to enable crews and passengers to leave the aircraft after an emergency crash landing. Escape systems for helicopters have shown very promising results so that one can hope that the existing gap can be filled in the near future. A statistical analysis of helicopter accidents, in particular of fatal accidents, gave good indications for further efforts in specific fields to reduce the lethality rate. It is possible to avoid a considerable proportion of fatalities by paying more attention to the safety factors.

Studies of best techniques for helicopter emergency landings gave new interesting stimuli to research increased flight safety.

THE HOVERCRAFT AND ITS POTENTIALITIES

by

Wg Cdr J.E. Burton, RAF

Ministry of Technology, Prospect House,
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RESUME

1. Exposé des principes techniques sur lesquels repose le Hovercraft, mettant en lumière l'importance de l'association du principe du coussin d'air avec le développement de "jupes" souples.

2. Description détaillée de l'organisation militaire britannique mise sur pied en 1961 dans le but d'évaluer le potentiel militaire du Hovercraft.

3. Description des deux familles principales de Hovercraft, le SR.N2/3 et le SR.N5/6. Exposé des types d'essais auxquels ces véhicules ont été soumis par l'Unité des Essais, en Angleterre et à l'étranger.

4. Intérêt actuel et futur présenté par le Hovercraft pour l'Armée de l'Air, l'Armée de Terre et la Marine.

5. Remarques générales sur le prix de revient et l'efficacité de ce type de véhicule.

6. Questions et débats.

THE HOVERCRAFT AND ITS POTENTIALITES

Wg Cdr J.E. Burton, RAF

Because of the limited time available to me, I will limit my presentation to a brief description of the hovercraft design, a discussion of the scope of the work we have been doing investigating the military potential of the hovercraft, and a few words about our future plans. First then, the general design of the hovercraft.

Low pressure air is provided by a fan and discharged by suitable ducting through a slot around the lower periphery of the craft. This slot feeds air into the cushion area underneath the craft and at the same time, the curtain of slightly higher pressure air round the periphery reduces the rate of loss of the air from the cushion. Since about 1962 the peripheral jet has been enclosed in a double-sided skirt made of rubberised fabric which effectively extends the slot downwards from the craft structure, thus providing a vertical obstacle-crossing capability by deflection of the skirt, of up to 90% of the skirt depth. The combination of the flexible extension (or skirt) with the air cushion principle has resulted in a great saving of installed power and has increased the obstacle clearance capability of a given craft by a factor of five or more. Contrary to ladies' fashions in my country, we hovercraft people like our skirts to be as long as possible! Generally speaking, the skirt length can be up to about one sixth of the beam of the craft and this is dictated by stability considerations, since the further the craft is away from the surface over which it is passing, the less stable it will be. In order to give the craft basic stability, the cushion area is compartmented by transverse inflated skirts. The object of lifting the craft on an air cushion is, of course, to reduce the resistance to motion whilst providing an obstacle clearance capability. Additionally, it gives the craft the ability to pass over a variety of surfaces such as water, mud, sand, marsh, snow and ice with equal ease and without need to pause when changing from one medium to another. Current amphibious craft are powered by gas turbine engines to take advantage of their low power to weight ratio. Installed power required is about 100 h.p. per ton of all up weight. The lift and propulsion are generally on integral shafts geared to supply about one third of the power for lift and two thirds for propulsion. Cushion pressures are kept as low as possible, the present generation of craft having cushion pressures of 40 lb. per square foot (200 kg. per sq.meter) which is about equivalent to the ground pressure exerted by a seagull standing on one foot. Control is by aerodynamic type controls operating in the slipstream from the propeller, by skirt lift, and by use of air jet reactions. The more sophisticated craft have the ability to angle the thrust of the propeller by swivelling the pylon on which the propeller is mounted.

We recognised a possible military potential following the success of the first full scale hovercraft, the SRN-1 in 1959, and set up a joint military Trials Unit in 1962. The Unit has had experience of all hovercraft that have so far been produced in the United Kingdom. We can say broadly that the work of the Trials Unit has been

concentrated mainly on the seakeeping performance of the larger craft and on the potential in sheltered water, amphibious operation of the smaller craft.

I would like to dispose of the larger craft first.

The SRN-3 was delivered to the Trials Unit in 1964. It is 77 ft long by 30 ft in the beam (24 metres by 10 metres) and has a weight of 37½ tons fully laden of which 12½ tons is payload. It is powered by four gas turbines of 900 s.h.p. each and has a maximum speed of 70 knots over a calm sea and a practical cruise speed of 50 knots. Work on this craft has been concentrated on proving the principle of Naval use of the hovercraft in the Anti-Submarine role using a dipping sonar similar to that used in the helicopter. Since the hovercraft has a good load carrying capability it can have all the necessary submarine detection equipment and can remain on station for long periods. In terms of over water performance in calm water the hovercraft is very superior to equivalent sized vessels. In moderate seas its performance and sea-keeping qualities are equivalent to those of a vessel of twice the weight, and in adverse weather it is capable of transitting at reduced speed in sea states which would stop vessels of equal size.

In the amphibious role, the Trials Unit have undertaken a large number of trials using the SRN-5 hovercraft. This craft first appeared in early 1964 as a commercial 15 passenger ferry. It is powered by a single 900 s.h.p. gas turbine and can carry a payload of 2½ tons over a range of 150 nautical miles. Its loaded weight is about 8 tons. Cruising speed is about 45 knots and maximum speed 60 knots. Trials have been done in various areas and include desert and Canadian Arctic terrain. In the desert the craft's potential in providing a rapid means of smooth transit was amply demonstrated. Some problems still exist, of course, and these are mainly concerned with engine filtration and skirt wear. In the Arctic, the craft showed great promise as a means of opening up areas which are cut off by the winter for six months of the year. Performance was, of course, superior in the colder air and as expected there was even less friction when operating over ice. Problem areas were concentrated on winterisation of equipments and of the flexible skirt. Though the hovercraft can range freely over relatively smooth, level areas such as desert, it will be somewhat limited in terms of speed and hill climbing ability over the kind of close country that we have in Europe. In these conditions it may be necessary to operate only over previously surveyed and graded routes to ensure that no obstacle will be encountered which is beyond the craft's capability. For reduced range of operation, the craft can, of course, negotiate terrain which would stop any other vehicle.

As an extension to the Trials Unit, we formed a semi-operational hovercraft unit equipped with two SRN-5's and sent it to the Far East for the whole of 1965. The Unit was stationed for part of the time in Singapore, part in Borneo, and for a short time in Thailand. In the Singapore straits, the craft was operated very successfully in co-operation with Naval vessels, in the Coastal Forces role as a high speed patrol boat both by day and night, having the added capability over conventional boats of being able to traverse shallow water and sand banks. In Borneo, the craft spent the majority of the time being used in the logistic support role for the Army along the main river communications of the country. The craft distinguished itself in this role showing that it could negotiate small rapids, floating debris and tidal rivers which would normally be impassable or hazardous to other river traffic. The only alternative means of supply in such terrain was the helicopter which was limited in payload and by

weather, due to the mountainous nature of the country. Our Far East Unit further proved the potential of the hovercraft by carrying out a short trial over the paddy-fields of Thailand. This seemed to convince our American friends that there was a role for these craft in Vietnam and the United States Navy subsequently bought three of our SRN-5's, armed and equipped them and put them into operation very successfully in the Mekong Delta. I think this operation was an ideal example of how the hovercraft should be considered as being complementary to the helicopter and not in competition with it. In the task in Vietnam, an armed helicopter was paired with each of the SRN-5's in a search and destroy type of operation. The situation was that the water levels were falling over this large generally inundated area and it was not possible to use conventional water borne craft. The helicopters could not land because of the flooding. The speed and mobility of the hovercraft was far superior to conventional vehicles and the helicopters were able to direct them in pursuit of suspected Viet Cong through marsh, swamp, heavy grassland and light brush with great efficiency. The force of three hovercraft and three helicopters, in the words of the Americans, achieved as much in one week as would have taken three months using other means.

As well as the roles I have described, the hovercraft has a good potential in the ship to store logistic supply task. In the past, this task has been done by slow moving boats which can go no further than the beach and sometimes due to shallow water not even as far as that. The higher speed of the hovercraft should enable the supply ships to lie off in a less vulnerable area further from the coast, their use will provide an ability to get men and supplies ashore without getting wet, and flexibility should be improved in that landing areas need not be dictated by depth of water nor by the state of the tide. All these considerations and the success of our trials around the world have encouraged the British Army to form its first purely operational hovercraft squadron, equipped with four militarised versions of the SRN-6, capable of operation in selected areas of the world in the logistic support role. The SRN-6 is a lengthened version of the SRN-5 capable of carrying a further ton of payload at the expense of slightly reduced performance. In addition, the Army plan to carry out experimental trials with the BH-7, which is a 40 ton craft specially designed for the logistics role. The Navy also plan to use a version of this craft in the fast patrol boat role. In addition, the Navy have ordered a study into the possibility of building a hovership, initially of 300 tons and possibly later of up to 1000 tons for use in the Anti-submarine role. The Royal Air Force have stated a requirement for a hovercraft based on the military SRN-6 specially adapted to carry fire fighting and rescue equipment. A large number of our airfields are on the coast and are surrounded by terrain which at low tide is impassable to normal vehicles and vessels, other than helicopters. The helicopter is limited in payload and cannot effectively fight a fire or rescue large numbers of survivors. The hovercraft would be capable of carrying a payload of 6000 lb. (2720 kg.) of equipment plus crew and after some of this equipment has been discarded, of transporting 50 survivors to safety. The Ministry of Defence are considering purchase of a number of these adapted SRN-6 craft to augment the existing fire/rescue facilities at certain airfields.

As a means of providing a relatively smooth ride over a variety of water and overland surfaces whilst having at least 40% and in emergency 100% of its all up weight as payload, the hovercraft would appear to have excellent prospects. It has attractions as a casualty evacuation vehicle apart from the roles which I have mentioned Its disadvantages are that it is noisy and at this early stage of its development it is fairly expensive in initial cost, but not in expense of maintenance or operation. The noise

problem is capable of solution when it is appreciated that the air propellers presently in use are taken direct from aircraft. Since they are designed for different speed regimes, they are far from efficient and moreover the propeller tip speeds are unnecessarily high and this is the main source of noise in the present generation of hovercraft. We have initiated a development programme aimed at producing a hovercraft propeller which will be both more efficient and less noisy. The initial cost of the hovercraft will decrease with the passage of time as more and more of these vehicles come into use and the cost of development can be spread out. Weight for weight in terms of payload, the hovercraft is considerably cheaper than the helicopter and likely to become more so. Maintenance is simpler and cheaper and standards need not be so stringent as with the helicopter. Crew skill can be less and therefore training will be cheaper. Generally speaking a hovercraft is safer than a helicopter and it can operate in much worse weather conditions. Having said all that, I want to stress once again that the hovercraft has not been developed to be in competition with the helicopter. We consider that its particular virtues should be complementary to rotary wing aircraft.

PANEL CHAIRMAN'S CONCLUDING REMARKS

Many of us in AGARD, and in particular in the Aerospace Medical Panel, feel that one of its most important functions is to bridge a gap between research and the practical problems of air operations within the NATO forces. This would seem to be a fitting task for a military research agency but at some meetings which I have attended, emphasis has been on laboratory research without perhaps a full appreciation of the problems in the field.

Last spring the Aerospace Medical Panel held a short meeting in which flash blindness was the subject under discussion. This brought together visual physiologists and members of Air Staff as well as aero-medical authorities, and resulted in a successful and useful exchange of knowledge. This was in part due to the fact that the programme was planned around a single theme and contributions were sought from speakers selected for their knowledge in one or other particular field. This helicopter symposium has been a similar exercise, and it has brought together not only research scientists, aero-medical authorities and air staffs, but it has also had a direct input from those operating helicopters in recent war operations. I should like to mention in particular the value of the papers we have listened to regarding recent military experiences.

Circumstances prevented me from attending all the sessions but in closing the symposium I should like to thank all those who made it so successful - all those who contributed papers, who acted as chairmen of sessions, the interpreters, the AGARD administrative staff and all those attending. I should like to make special mention of Wing Commander D.I.Fryer, the chairman of our Editorial Committee, for undertaking the task of laying out the symposium and inviting speakers, and Lt Colonel H.Grunhofer the Aerospace Medical Panel's Executive Officer for his general support.

H.L.Roxburgh, Air Commodore, RAF
Chairman, Aerospace Medical Panel

TECHNICAL SUMMARY

CIRCULATED IMMEDIATELY AFTER THE SYMPOSIUM

A symposium on this highly topical subject was held at NATO building, Porte Dauphine, on May 22nd – 24th inclusive. Over sixty people participated representing the Armed Forces of ten NATO member nations, and twenty-six papers were presented. In addition, several films were shown and there was spirited discussion on many topics which were not specifically covered by formal papers.

The meeting was opened by the Director of AGARD, Dr Jones, who drew attention to the great potential value of symposia in which executive and specialist branches of the services can get together around the conference table and discuss in depth the nature of a particular task, the means by which it is tackled by member nations and the problems which have not yet been solved satisfactorily.

The interest shown in this specialist symposium was reflected in the presence during the opening session of General Stromberg, MCREP, who in a brief welcoming address emphasised the value to the Military Committee of the deliberations of the panels of AGARD.

The first session, chaired by Colonel Malone of the US Air Force, dealt with the Helicopter as a Carrier of Personnel and Material. A clear picture of the tasks faced by helicopter operators was gained from speakers with command experience in Malaya, Borneo, Vietnam, the Arabian Peninsula and in a UK seaborne strike force. There were also dramatic firsthand accounts of non-military rescue work in British coastal waters, in the Italian flood disasters of 1966 and following the foundering of a Danish ferry from which 144 persons were saved.

The second session on The Helicopter as a Casualty Evacuation Vehicle, under the chairmanship of Air Commodore Yerbury of the RAF was introduced by the showing of a brilliantly produced "Cinéma Vérité" film of front-line helicopter casualty evacuation in Vietnam by the US Army and the subsequent treatment of a casualty culminating in air evacuation to the American continent by the USAF Military Airlift Command. The audience subsequently learned with great interest of the intense activity of the International Red Cross Organisation, largely stimulated by the work in committee of a panel member, Général Major Médecin Evrard, Belgian Air Force, towards the clarification and modernisation of the Geneva Convention as it affects casualty evacuation by air. Subsequent papers gave clear descriptions of the organisation and techniques of casualty handling in modern guerrilla-type warfare and "confrontation" in the hostile environment of the Far and Middle East.

Next on the programme was a session on Aircrew Problems in Helicopter Operation in which pilots, research workers and doctors who are also qualified helicopter pilots outlined and discussed the many physiological and psychological stresses imposed on the crew of rotary-wing aircraft. Under the guidance of the session Chairman, General Lauschner of the German Air Force, opinions and experiences were exchanged on many subjects, including noise, vibration, vision, instrument flying, selection and training. There was also a most interesting discussion on the causes, effects and treatment of fatigue arising from intensive helicopter operations.

In the final session under the Chairmanship of Général Major Médecin Evrard the Hazards of the Helicopter were described in a survey of helicopter accidents. There were excellently illustrated presentations on the investigation of the sequence of events in deliberate crashes and on the research currently in progress on means of reducing the injury potential of helicopter accidents by piloting technique, crew escape training and advanced escape systems.

Finally, a glimpse into the future was provided in a paper by a very experienced RAF pilot who has been intimately concerned with the testing of hovercraft and the development of utilisation techniques for their military exploitation.

In summarising the whole meeting's deliberations the Chairman of the ASMP and the project officer emphasised the Research and Development guidance which could be derived from this type of meeting. Many problems had been discussed in which collaboration between NATO member nations by sharing of technological skills, exchange of equipment and pooling of research facilities could rapidly bring results which would improve efficiency and enhance safety in the use of the helicopter in its tactical role.

Among the fields in which AGARD should take the initiative in fostering collaborative projects the meeting had revealed clear needs in the following:

1. The development of rescue and survival aids in which the risks inherent in the use of such equipment are reduced, e.g.

(a) strops from which people without training cannot accidentally fall;

(b) aids whereby personnel awaiting rescue can be sure of location in all circumstances, particularly those in which vegetation etc. might impede or prevent direct visual detection;

(c) protective equipment whereby rescue personnel may be lowered into jungle and other hostile environments and casualties and "downed" aviators may be rescued from such conditions with maximum speed and minimum injury.

2. Education of the military personnel, civilian authorities such as the police, fire brigades, ship owners, coast guards, civil defence organisations and the general public in the following matters:

(a) the preparation and marking of landing sites, pick-up sites, etc. including the clearance of obstructions;

(b) the limitations imposed by terrain slope, obstructions, altitude, load, wind, darkness, etc. on helicopter operations;

(c) the importance of clear and standardised notification of casualty numbers, condition, priority, location and pre-rescue therapy.

Included in this educational programme should be the preparation in advance of instructional leaflets and broadcast scripts for use in emergencies such as floods, wrecks, etc.

3. Military passengers, whether fit outbound troops, casual passengers, sick casualties or rescue teams should be afforded better protection from the hazards of the helicopter and the terrain over which it flies. Included in this category would be:

(a) the provision of universal-fit helmets with good impact and acoustical protection properties, but designed to permit both direct hearing by displacement or opening of the ear-insulating portions and in-flight communication between commander and passengers, perhaps by the loop system with consequent elimination of encumbering R/T cords;

(b) the provision of suitably effective flotation aids for *fully armed and equipped* military strike personnel.

4. There should be collaboration to design a litter or stretcher which would combine as many as possible of the following features:

(a) light-weight, low bulk and cheap construction (disposable)

(b) universal fit in the helicopters of NATO nations

(c) radiotranslucency

(d) adequate support for prone or supine patient carriage

(e) stressing and strong-point location to permit winch-hoist

(f) a disposable shield to provide cover for through-trees hoist

(g) flotation in the event of "ditching"

(h) suitability for utilisation in external "pannier" stowage.

Such a device could enhance casualty management enormously by reducing the amount of patient handling in transit. A casualty would thus be subjected to minimal unnecessary disturbance during pick-up, carriage by air, by hand, by road, during X-ray investigation, and during surgical treatment.

5. There should be collaboration on the design of inexpensive, low-bulk and light resuscitation apparatus to provide positive-pressure cyclic pulmonary ventilation with oxygen and also facilities for suction to maintain a satisfactory airway. The apparatus should function independently of aircraft power or oxygen supplies and be sufficiently robust to withstand rough handling during winching etc.

6. Aircrew fatigue studies are vitally important but experience indicates that progress in the measurement and analysis of the mechanisms of physiological disturbance is unlikely to be rapid. It is essential that immediate attention is given to the amelioration of those features of the aircrew task and environment which engender fatigue. These include:

(a) better seating with reduction of transmitted vibration

(b) better acoustic insulation

(c) better instrumentation and controls

(d) development of reliable autostabilisation systems applicable to utility and light helicopters

(e) improved visibility with minimal distortion and internal reflection

(f) provision of better maps and holders for in-flight use

(g) provision of warning devices to sense the proximity of cables and other hazards

(h) aids to pre-flight preparation such as the on-board display of all-up weight and centre of gravity location

(i) improvement of energy-absorption seat mountings, de-lethalisation of the cockpit, fire suppression, impact fire prevention by fuel tank and fuel line design changes etc.

7. Studies of future vehicle design and deployment requirements should be continued and their results widely circulated.

D.I.Fryer
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Project Officer

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